GLASS-MAKING IN ENGLAND

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GLASS-MAKING
IN
ENGLAND

BY

HARRY J. POWELL, C.B.E.

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TO

MY WIFE

PRINTED IN GREAT BRITAIN

PREFACE

SEVERAL BOOKS have been written about the craft of the collector of old English glasses and about the craft of the dealer in antiques, but the history of the handicraft of glass-making has only received cursory attention.

The history of glass-making in England is dealt with from a collector's point of view in Hartshorne's *Old English Glasses*; it is briefly noticed in Nesbitt's *Handbook of Glass*, and some valuable papers by E. Wyndham Hulme on "English glass-makers of the sixteenth and seventeenth centuries" appeared in the *Antiquary* towards the end of the last century.

Few genuine handicrafts remain, and the handicraft of glass-making is doomed, owing to the scarcity of recruits and the development of machinery. The training required to equip a competent glass-blower is long and arduous, and the prospect of ultimate success is not sufficiently bright to attract youths to adopt glass-blowing as their trade. Moreover, training is less easily obtained now than in the past because many simple processes, which used to afford practice for learners, are now more speedily and economically carried out by improved mechanical appliances and by machinery. A modern automatic bottle-making machine sucks up molten glass from a feeding-tank and turns out finished bottles continuously as long as the tank is supplied with glass, and the machinery is kept lubricated and adjusted.—The last fifty years have witnessed greater changes in the glass industry than in any other. The conception of the material itself is changed; many of its physical and chemical characteristics differing widely from those of a rigid solid. Whereas the varieties of glass, chemically distinct, could formerly be counted on the fingers of one hand, they are now numbered by the hundred. Rule-of-thumb methods are yielding to scientific methods, primitive tools are being superseded by machines of great complexity, and handicraftsmen by engineers and mechanics.

The foundation of the Glass Technology Society in 1917, the establishment of a School of Glass Technology in connection with Sheffield University and the inauguration of a National Glass Research Association

prepare the way for the speedy development of the industry on modern scientific lines.

As the threatened handicraft possesses both antiquity and interest, it may not be amiss to try to piece together the few records which are now available in order to form a framework into which fuller information can be fitted in the future.

I wish to make acknowledgments to the late Albert Hartshorne for his friendship and for stores of information contained in *Old English Glasses*; to Mr Francis Buckley for his generosity in placing at my disposal the results of his long and laborious researches; to Mr E. F. Chance for his paper dealing with the history of the Spon Lane Works; to the late Rev. F. S. Cooper for many facts about the Old Chicklingfold Glass-houses; to Mr E. Thurlow Leeds for his assistance and for his pamphlet on the "Dating of Glass Wine-Bottles"; to Mr J. A. Knowles of York for several valuable suggestions, to Mr Wilfred Buckley, to Mr Dudley Westropp, and to a long succession of able craftsmen at the old Whitefriars Glass-house to whom I owe whatever practical knowledge of glass-making I may possess. My thanks are also due to Mr Edward Arnold, to Messrs Pilkington Bros., to the editor of the *Nineteenth Century*, and to the proprietor of *Country Life* for permission to make use of illustrations and articles.

H. J. P

October 1922

POSTSCRIPT

It is with deep regret that the publishers announce that the author did not live either to see his book published or to witness the transference of the glasshouse, which was the centre of his life's labour, to a new locality, the old Whitefriars Works, which for more than two centuries rested under the shadow of St Paul's, having now been removed to Wealdstone, Harrow.

Mr Harry Powell's whole attention was focused upon the craft of glass-making as an English fine art and it was one of the regrets of his later years to note the passing of the old-time craftsman. Modern conditions of education and industry call for new methods of training, and with this end in view it was decided to remove the glasshouse to more healthy surroundings, to take advantage of the latest developments in the science of glass-melting, and to provide adequate means for the systematic training of young men in the craft.

These plans have now materialised and although, as the Lord Mayor pointed out at a farewell visit to the old works, London has lost one of its ancient landmarks, it is to be hoped that the craft of glass-making will benefit by the change.

January 1923.

ERRATUM

On page vi '*to Mr J. F. Chance for the help given in the compilation of Chapters VII, VIII and IX*' should be substituted for '*to* Mr E. F. Chance for his paper dealing with the history of the Spon Lane Works'.

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CHAPTER I

ROMAN GLASS IN ENGLAND

A BIOGRAPHER examines the ancestry of the man whose life he records in order to trace the development of peculiar traits and talents. Similarly, in order to understand the technique of a craft its

Fig. 1. Square jug, made in mould, with strongly fixed handle. British Museum.

ancestry must be investigated. The technique of English glass-blowers can be traced back to the glass-blowers of Imperial Rome and to the Roman provinces of Syria, Egypt and Gaul.

It does not appear that during the Roman occupation glass-working, except the making of beads and, possibly, of small cups and bottles, was carried on in any part of the British Isles. It is claimed that at Wilderspool, near Warrington, the foundation of a Roman glass-furnace, together with fragments of glass and a piece of a crucible, have been discovered. The remains, however, are so insignificant that the glass-factory

Fig. 2

Fig. 3

Fig. 2. Roman jug with strongly fixed handle; threaded decoration. Found at Barnwell, Cambridge. British Museum.

Fig. 3. Roman jug, with glass impressed seal. Surface ribbed by moulding. Found near Sittingbourne. British Museum.

must have been of small extent. But even if Roman glass-works did not flourish in Britain, the vessels and fragments of vessels scattered broadcast through the land prove by their technique how much modern glass-workers owe to their Roman predecessors. The similarity in form, and in chemical composition of Roman glass vessels, whether found in

England, on the Continent, in Syria or Egypt, makes it probable that there were only a few centres of glass manufacture, and that the vessels were distributed from these centres through the whole empire.

At Silchester and on the sites of other Roman settlements fragments have been found of window glass, both sheet and plate, differing but slightly in composition from that of modern glass. The moulds used for

Fig. 4. Roman cut crystal-glass cup, height $5\frac{3}{8}$". Found at Barnwell, Cambridge. British Museum.

shaping vessels and for impressing patterns on their surface were as perfect for the purposes for which they were intended as those of the present day. The handles of the Roman jugs and jars were perfectly constructed and scientifically attached (Figs. 1 and 2), the strain of leverage being amply allowed for. Spouts were formed as they are formed now, and seals or "prunts" of glass and coils and loops of glass-thread (Figs. 6 and 7) were added as forms of decoration. Pliny describes how patterns were cut by pressing the surface of vessels against revolving wheels of hard stone. At Wilderspool fragments of Roman glass, cut with patterns (Fig. 5), have been found and also a small stone cutting-wheel. In the

British Museum is an almost colourless Roman glass cup (Fig. 4), cut with hexagonal hollows, which was found at Barnwell, near Cambridge.

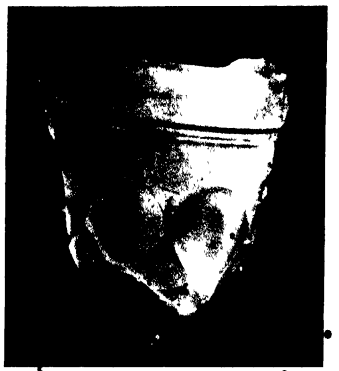


Fig. 5. Fragment of cut Roman glass, found, with a small cutting wheel, at Wilderspool. Warrington Museum.

Roman cutting consists of patterns composed of lines and shallow concave hollows, circular, hexagonal or octagonal in shape. This shallow-cut

Fig. 6 Roman vases with decoration of loops and trailed lines of glass.

decoration sufficiently brings out the brilliancy of the material without distorting the outline of the vessel to which it is applied, and in this respect is superior to most modern cut decoration, in which grace of outline is too often sacrificed in order to secure brilliancy by deep cutting

Glass-making in England is therefore in debt to Imperial Rome for much of its technique and for the chemical composition of at least one of the many kinds of glass which are now made.

Fig. 7. Vase with handles; coil of thread as decoration; found in Colchester. Colchester Museum.

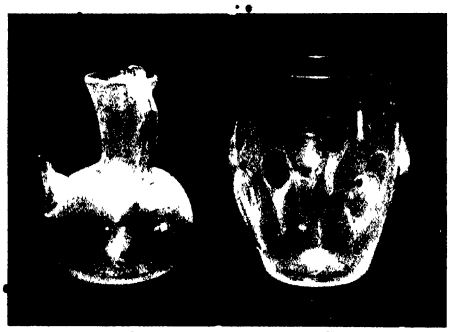
Blue-tinted Roman Glass

The composition of the blue-tinted glass, of which so many of the larger Roman jugs and cinerary jars are formed, throws an interesting light on Pliny's account of the discovery of glass. His attribution of the discovery to certain Phoenician merchants shipwrecked on the coast of Syria, near the mouth of the river Belus, may be inaccurate, but the development of a durable glass from the deliquescent silicate of soda, which the merchants found mixed with the ashes of their camp fires, is precisely and scientifically traced. If, as Pliny states, the cooking pots

were supported on blocks of natron (impure carbonate of soda) the heat of the fire would bring about the combination of soda with the seashore sand, and the glass-like substance, silicate of soda, would be formed. Experience must soon have shown that sand and soda, alone, could not produce a stable, workable glass, and Pliny, in the chapter which follows the description of the wreck, states that "after a time a material called Magnes lapis began to be added." In a subsequent chapter five different kinds of Magnes lapis are described: "the fifth is white, resembles pumice powder, does not attract iron and is found in Magnesia." This undoubtedly is magnesian limestone, and no better material could have been introduced into the mixture of sand and soda in order to make a durable glass. Analysis shows that these are the materials from which the blue-tinted Roman vessels were made, and the preservation of the glass is sufficient proof of its durability.

"ANGLO-SAXON" GLASSES

In the Museum of Saint Germain is a curious Roman glass vessel (Fig. 8 B), which is cup-shaped and has eight hollow excrescences or



A B

Fig. 8. A, Roman feeding bottle with glass spout. B, Roman vase with hollow depressed lobes. St Germain's Museum.

lobes, made like small spouts, but with the ends turned downwards and fused to the side of the cup. This little vase, for it is difficult to imagine that it had any domestic use except as an ornament, forms an important

Fig. 9

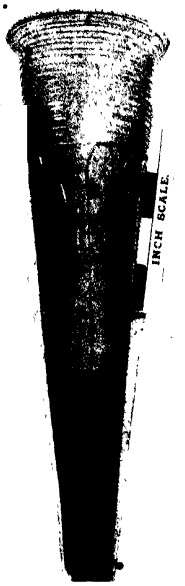


Fig. 10

A

Fig. 11

B

Fig. 9. Threaded mouth and base; hollow lobes. Found near Sittingbourne. British Museum.
Fig. 10. Threaded mouth and loops of thread. Alfriston, Sussex. Photo by Mr J. C. Stenning.
Fig. 11. A, Threaded mouth. B, Strap decoration. Found at King's Field, Faversham.

Fig. 12

Fig. 13

A

Fig 14

B

Fig. 12. Threaded mouth, notched lines. King's Field, Faversham. British Museum.
Fig. 13. Found at King's Field, Faversham. British Museum.
Fig. 14. A, Found at Coombe, near Sandwich. B, Found at Bishopsbourne, Kent.

link between Roman glasses and the so-called "Anglo-Saxon" glasses which have been found in Anglo-Saxon graves of the sixth and seventh centuries of our era. There are several varieties of these glasses but the most important are from six to nine inches in height, have small bases, threaded mouths, and a number of hollow spout-like lobes, formed like the lobes on the Roman cup in the Saint Germain's Museum. (Fig. 9.) Similar vessels are found in graves of the same period in France and Germany. Roman technique survived in certain parts of Germany, notably in the Cologne district, and from this centre the vessels may have found their way to England as well as throughout the rest of Europe.

In England the largest number of Anglo-Saxon glasses have been found in Kent, which provided the most convenient landing-places for imports from abroad, but specimens have also been found near Cambridge and Oxford as well as in Northamptonshire, Suffolk and Sussex. Associated with the "lobed" glasses are various forms of drinking vessels. There are simple bowl-shaped cups, similar to some depicted in the Bayeux tapestry; conical and trumpet-shaped tumblers ornamented with long loops of glass-thread (Fig. 10), and spindle-shaped vessels with threaded mouths and notched strings or tears of glass running nearly their full length (Fig. 12). The notched strings or "tears," as well as the hollow lobes and the threaded necks, are survivals of Roman technique. Some of the simple bowl-shaped cups may have been of local manufacture.

Fig. 15. Rib-moulded cup. Found at Alfriston, Sussex.

CHAPTER II

GLASS-MAKING IN ENGLAND

CHIDDINGFOLD

AMONGST the ancient maps painted on the panels of the cupboards of the Guarda Roba of the Palazzo Vecchio in Florence is a map of England, in which the county of Surrey contains only two names, Guildford and "Chedingfield" (Chiddingfold). The map was painted in 1565 and suggests that Chiddingfold, which is now a sleepy village, was then regarded in Italy as of not less importance than a county town. This may have been due to the fact that for centuries Chiddingfold had been recognised as the chief centre of glass-making in England.

Chiddingfold is in the Haslemere district, south of Godalming, and close to the boundary line of Sussex. The neighbourhood is still thickly wooded, and a large-scale Ordnance map bears witness to the existence in times past of tracts of dense forest. Sites, too, are marked of disused sand-pits and limekilns, and names, such as "Glass-house-copse," "Glass-house piece," and "Kiln-copse," tell the story of a dead industry which required for its sustenance sand and lime as well as the fuel and alkali supplied in abundance by the woods. It is not known when the industry was started, but in the sixteenth century it was already of great antiquity. At first probably the manufacture was restricted to rude cups and bowls for domestic use roughly made of coarse greenish glass. Such primitive drinking vessels, which may well be native products, have been found in Anglo-Saxon graves associated with lordly and elaborate beakers of foreign origin. The fact that in the seventh and eighth centuries it was necessary to send abroad for skilled artisans to manufacture glass windows and ecclesiastical vessels, does not disprove the existence of makers of humbler products in the wilds of Surrey.

The information which has been gathered about the early glass-workers in Surrey and Sussex is almost entirely due to the researches carried on through a number of years by the late Rev. T. S. Cooper of

Chiddingfold. The first authentic record, referring to glass-making in England, is a grant by Simon de Stocha, who was living in 1226, of twenty acres of land in Chiddingfold to Laurence the glass-maker (Vitrearius). In a deed of 1280 the "oven-hus-veld" is mentioned as a boundary. This field has been identified and within its area fragments of fused glass and of broken crucibles have been discovered. In another deed, dated 1300, William "le Verir" of Chiddingfold is mentioned.

From the fragments of crucibles which have been found in various parts of the district it has not been difficult to determine their shape. They were open bowls, made of clay, with incurved mouths, varying in thickness from one to two inches. The largest of the crucibles must have been about twelve inches deep, eleven inches across the base, and nine inches across the contracted mouth. It is less easy to reconstruct the furnaces and the factories or glass-houses, which sheltered them. The glass-men moved frequently from place to place in search of fresh supplies of fuel. Beech-wood was their favourite fuel and the side of a wooded hill their favourite site. The glass-houses were temporary wooden structures with large openings left in roof and walls for the escape of smoke and for free access of air. The monk, Theophilus, who wrote, probably in the thirteenth century, has left a description of a glass-furnace in his *Schedula diversarum artium*, and there is a Flemish drawing of a glass-furnace of the latter part of the fifteenth century in the manuscript department of the British Museum. It was an oblong building of "stones and clay" about fifteen feet in length by ten feet in width. It was divided perpendicularly by a wall into two chambers, one for melting the glass and the other for annealing or cooling the glass-ware when made. The whole was covered by an arched crown, the part over the melting chamber being higher than the rest. The crucibles stood on a raised platform in the melting chamber, and fuel, in the form of beech-wood billets, was introduced through an opening at a lower level. There was a small hole in the upper part of the wall dividing the two chambers, and a larger opening or chimney for the escape of smoke and wasted heat in the crown of the annealing chamber. On a level with the crucibles in the walls of the melting chamber were arched apertures, which could without difficulty be wholly or partially closed, for placing the crucibles in position, filling them with raw material and removing the melted glass.

Another, but later form of furnace, was in shape like an old-fashioned beehive, with a basement and two vaulted floors. The basement was for burning fuel, the first floor for the crucibles, and the upper floor for the first process of annealing the manufactured glass. A central opening through the floors and dome served as chimney, and the wall of each floor had one or more external openings. Adjoining the furnace was a tunnel-shaped oven, called the "leer[1]," about eighteen feet in length by four feet in width, by two feet in height, with a fireplace and an opening at the end nearest the furnace, and another opening at the

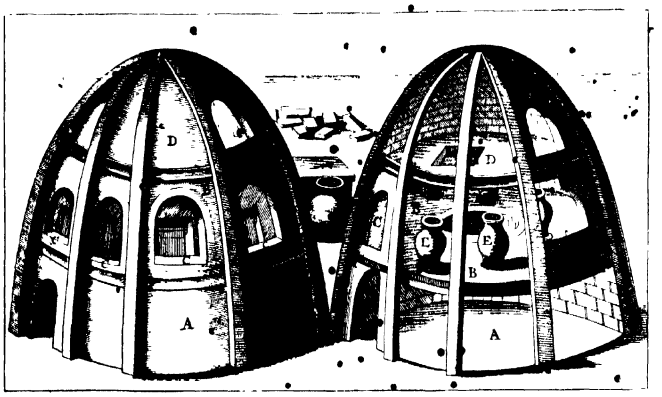


Fig. 16. Seventeenth century glass furnace.
A, Fuel chamber. B, Melting chamber. C, Working openings, with temporary screens or "collars." D, Annealing chamber. E, Crucibles.
Blancourt's *Art of Glass*, English Edition, London, 1699.

opposite end. The glass-ware was removed with a fork from the top floor of the furnace into a movable iron pan resting near the fire in the leer, and was gradually cooled by pushing the pan away from the heat. A pan when filled and moved from the fire was replaced by an empty one. There were at least three other ovens or kilns: one for baking and heating the crucibles, one for burning brake-fern or beech-wood into ash for the extraction of alkali and a third called the "calcar" in which the mixture of raw materials underwent a preliminary fusion to form the "frit."

With regard to the preparation of the alkali, Theophilus gives the

[1] "Leer," so spelt in Merret's translation of Neri's *Art of Glass*, 1662.

following instruction: "If it please you to make glass, first cut up much beech-wood and dry it well: then burn it equally and, diligently collecting the ashes, be careful not to mix any dust or stones with them." The ashes were placed in cauldrons of water and a crude carbonate of potash, known as pearl ash, was obtained by evaporation. Brake-fern, which had been cut when green and "at such time as the moon was increasing and near its opposition to the sun," was similarly treated.

A mixture of the extracted alkali with sand and a small proportion of lime was heated in the "calcar" until partly fused. When cool the fused

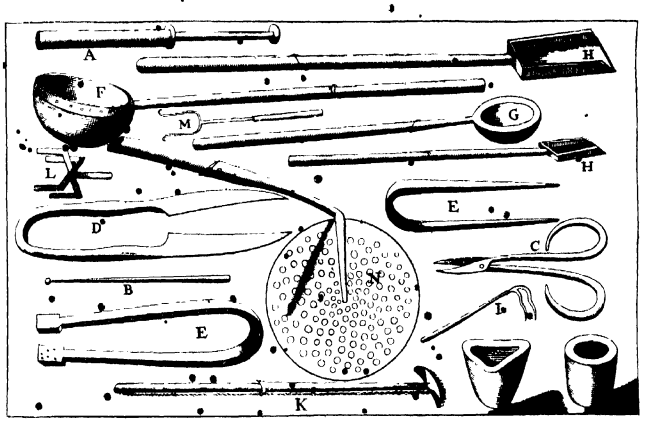


Fig. 17. Glass-making tools.
A, Blowing-iron. B, Pontee or puntee. C, Scissors. D, Shears or shaping-tool. E—N, pincers, ladles, shovels, drainers and other implements used in glass-making in the seventeenth century. Blancourt's *Art of Glass*.

mass, called "frit," was broken into fragments and shovelled into crucibles standing in the melting furnace. In the crucibles the frit melted, became fluid and threw to the surface a scum of impurities. After the scum had been removed by skimming the remaining glass was ladled into pans of water. The water was drained off and the glass, when dry, was replaced in the crucibles for final melting.

When the second fusion was complete a sample of the glass was taken by dipping an iron rod into the crucible, and if the glass proved to be of good colour and fairly free from bubbles, work was started.

The tools of the early glass-blowers were very simple, the most

important being the blowpipe, the pontee, the shaping-tool and the bench or "chair" on which the worker sat. The blowpipe consisted of a wooden mouthpiece attached to about three feet of small-bore iron pipe. The end of the pipe was heated, dipped in the molten glass, and twisted so as to collect a coil of glass, just as thick treacle may be coiled

Fig. 18. Seventeenth century glass furnace; showing blowing-irons, marvers, moulds, and a broken wine-bottle; also arched openings for withdrawal of glass and for working, with temporary screens for reducing the size of these openings.

round the bowl of a spoon. When a sufficient weight of glass had been collected ("gathered") the workman breathed into it through the mouthpiece and gradually formed a hollow ball or bulb of glass, the first condition of every kind of hollow vessel. The shaping-tool resembled a large pair of sugar tongs, made of iron, with long blades in place of spoons

It was used to grip the glass bulb, elongate it if necessary, and press it into any required shape. The "pontee" was a rod of iron, from four to five feet in length, used for gathering small pieces, or seals, of molten glass and for temporarily holding, by means of a seal, a glass vessel in process of manufacture.

The workman sat on a wooden stool between parallel, projecting arms, on which he balanced the blowing-iron or pontee carrying the vessel, and rolled it backwards and forwards whilst shaping it by the pressure of his tool. Whenever the glass became cold, the vessel was thrust through an aperture in the furnace to regain plasticity by re-heating.

With these primitive tools small bowls cups and bottles were at first produced, and as the skill and experience of the glass-men increased bulbs were made of sufficient size to be converted into flat window-glass.

The instructions of Theophilus for making "brode," "spread" or sheet-glass are rather involved: (1) pierce the end of a large elongated bulb and widen the aperture to equal the bulb's largest diameter; (2) pinch together the mouth thus formed so that the narrow space remaining can be spanned and held by a seal of glass attached to a pontee; (3) break the bulb, now supported by the pontee, from the blowing-iron, and widen the aperture due to the breakage so as to form an irregular cylinder; (4) detach the cylinder from the pontee, anneal it and, when cold, split it from end to end by the application of a red-hot iron; (5) place the cylinder on the flat bed of an oven, heat it, and as the cylinder opens, owing to the heat, flatten (spread) it into a sheet by means of a rod of iron or wood. Another process of making flat glass in the form of discs or "crowns" is not described by Theophilus. In this process the bulb was caused to widen instead of to lengthen, so that its diameter greatly exceeded its length. A pontee held by an assistant was cemented by a seal of molten glass to the centre of the bulb opposite to its attachment to the blowing-iron. This attachment was severed by a sharp blow and the bulb, with an opening at the point of severance, remained sealed to the pontee. The workman took the pontee from the assistant, strongly heated the fractured opening of the bulb and by rapidly trundling the pontee, as a stable-man trundles a mop, caused the bulb to expand into a flat disc. Although the discs or "crowns," owing to their shape and the pontee mark, could only be cut into small

pieces, they had a brilliant surface and in this respect were more suitable for glazing than the spread sheets of "brode" glass.

The earliest reference to window-glass in England is in the Account Rolls, 25 Edward III, connected with the building of St Stephen's Chapel in Westminster. In 1352 John de Lincoln Master of the Works in the King's Chapel and John Geddyng were given a roving commission to "provide, procure and buy as much glass as should be required for the said Chapel and also to provide workmen, glaziers and others and carriages for the said glass." A list of twenty counties is given in which the quest might be made, Surrey and Sussex being the first two on the list. The following entries occur in the Accounts[1]: "October 30. John Alemayne for 303 ponder of white glass each ponder of five pounds, bought for the glazing of the said windows; W. Holmere for carriage of the said glass from Chiddingfold to Westminster 6/-." "Nov. 7. John de Alemayne for 36 ponder of white glass." "Dec. 12, 60 ponder of white glass, bought at Chiddingfold." Only white glass appears at that time to have been obtained from Chiddingfold.

In 1378 John Shertere (Schurtere), a glass-worker of Chiddingfold, died. His widow, Joan, engaged a Staffordshire man, John Glaswryth, to carry on the work for her for six years, and arranged that he should receive "20*d*. per shen or shev of brode glass and 6*d*. for every hundred of vessel." This proves that the same glass-house turned out both drinking vessels and flat glass for glazing.

The Shertere glass-house passed into the hands of the Ropleys, and then to the Peytos, in whose hands it remained until the early part of the seventeenth century. The burial registers of Chiddingfold Church contain the following entries: "1610 John Peytoe, glass maker: 1614 Will Peyto, glass-maker."

Sometime after 1551, as recorded in Thomas Charnock's *Breviary of Philosophy*[2], published in 1557, a mysterious foreign glass-maker was established in or near Chiddingfold. He was a person of some importance and of considerable dexterity. He had to be approached by applicants for his wares "in most humble wise" and he could make a glass box of the shape of an egg which would open and shut "as close

[1] *Antiquities of Westminster*, The Old Palace, St Stephen's Chapel. John Thomas Smith. 1807.

[2] Printed in Ashmole's *Theatrum Chemicum*. 1651.

as a haire"; no mean achievement. An inquiry in 1567 as to the manufacture of window-glass in Chiddingfold elicited the reply that no window-glass was then being made, but only small articles and rough goods such as urinals. It is possible that the window-glass makers had already commenced their migration to Sussex, Hampshire and Gloucestershire. The inquiry arose in connection with an application by certain foreign glass-makers for a monopoly for making window-glass. The application was supported by Jean Carré (Quarre) residing in London, but a native of the Low Countries

INFLUENCE OF THE LOW COUNTRIES AND FRANCE

Some light is thrown on the condition of the glass industry during the sixteenth and seventeenth centuries by records of the applications for monopoly-patents, by the documents conferring licences and by complaints made concerning their effect. It is true that the promises contained in the applications were not fulfilled, the conditions imposed by the patents were not carried out, and that it is difficult to piece together a connected account.

In the last half of the sixteenth century owing to religious troubles in France and the Low Countries, and the consequent interruption to trade and manufactures, many foreign glass-workers were not unwilling to come to England, and the applications for monopolies hinge on the possibility of bringing them over. The applicants undertake that the glass, whether "flat or vessels," made by the foreigners in England shall be at least as good and as cheap as the glass then being imported, and promise that Englishmen shall be so effectually taught the "arte, feate and mysterie" that at the end of a fixed term they shall be able to make glass as well as the foreigners. The State-papers (domestic) of 1567 contain an application from Pierre Briet and Jean Carré (Carr or Quarre) (already referred to) for a licence for twenty-one years to set up a glass-house in London, similar to those in Venice, for the manufacture of crystal glass for drinking vessels. Briet and Carré belong to the Low Countries but are residing in England, and are recommended to Sir William Cecil by the Vidame (Steward) of the Bishop of Chartres. They state that they can obtain all the materials in the country, except soda, which will be imported from Spain, and propose to procure their

fuel from Arundel. That they wanted not merely a licence for making glass, but a monopoly of manufacture and the stoppage of the importation of foreign glass is proved by Carré's statement that he had already erected a glass-house for making Venetian drinking glasses in the City of London by leave of the Lord Mayor, as well as a window-glass

Fig. 19. Thick rib moulded flask. Found in Oxford.
Fragments of similar flasks found at Woodchester.
Victoria and Albert Museum.

factory in Sussex by the gracious permission of the Queen. It has been impossible to locate Carré's London glass-house, but, being connected with Antwerp, he may have been instrumental in bringing from that city the Venetian Cavato, who worked with Casseler, probably, in the Hall of the Crutched Friars. The application of Briet and Carré was closely followed by another in the names of Carré and Anthony Becku, alias Dolyn, for a monopoly of the manufacture of window-glass.

A monopoly for making drinking glasses was not granted, but a licence for twenty-one years for making window-glass is dated September 8, 1567. The concession is to Anthony Becku, alias Dolyn, and John Carré, born in the Low Countries under the dominion of our "deare brother Philippe King of Spayne." They are granted the privilege of exercising and practising the "arte, feate or mysterie of making glas for glasinge such as is made in Fraunce, Lorayne and Burgondy." No other person without their licence will be allowed to exercise the same art within the Queen's dominions; they are permitted to build "fournaces, howses, buildinges and other engins mete and necessaire" subject to proper agreements being made for the acquisition of sites; they are to render a just and faithful account of all the glass that is made, and pay as royalty such sums of lawful money as at this present or heretofore have been paid by merchants for such glass brought from any parts beyond the seas. Finally, they are bound to teach to the utmost of their "connynge" skill the perfect making of glass for glazing to a suitable number of Englishmen and will not be hampered by existing restrictions on the number of apprentices. All privileges, however, may be cancelled if at least two new furnaces have not been set to work by Christmas 1569. Carré, having obtained the monopoly, disregarded the joint interest of Becku, alias Dolyn, and took Pierre Briot into partnership. The first of the complaints is a letter from Anthony Becku, Carré's partner, to "The Rt. Hon. Sir William Cecill, Knight, the Queen's Majestie's principall Secretary," dated 1568. (Lansdowne MSS. No. 76.) Becku complains that he is unable to fulfil his obligations owing to the insubordination of the Lorraine glass-workers, who refuse to recognise his authority because his name was not included in the contract they had made with his partner Carré. Becku encloses a copy of a contract between John Quarre (Carré), John Chevallier and Thomas and Balthazar de Hennezel, Esquires. This contract requires Thomas and Balthazar de Hennezel, dwelling at the glass-houses in the Vosges, to transport themselves to England, to bring with them four gentlemen glasiers, namely two "tercieurs[1]" and two gatherers, and to build two ovens to make "great

[1] The word "*Tercieur*" may be the key to explain why a craft, practised in England for many years, had to be re-taught. The method described by Theophilus (see page 15) of making the glass cylinder which was to be flattened into a sheet, was extremely primitive, and seriously limited the size of the sheet. The end of the bulb which had been opened to

glas." Two methods of making flat window-glass have already been described, one method produced "tables," "crowns" or "circles" called "Normandy" glass; and the other produced "great glas," "brode-glass," "spread" or "sheet" glass, called glass of Lorraine or Burgundy (see page 15). The Hennezels are to be responsible for the supply of "sandes, asshes, Saffre[1] and all other provisions," and, unless prevented by sickness or "urgentletts," are to make every day in each of the two ovens thirty "bundells" of glass "whyte or coulleurs." The contract is to be in force for nine years. The dispute between Becku and Carré seems to have been complicated by disagreements between the glass-makers engaged by Becku, who came from Normandy, and the Hennezel contingent from Lorraine. In August, 1569, Richard Onslow and William More were sent from London to enquire into the quarrel between Anthony Becku, John Carré and Peter and John Bougan (Bongar).

John Carré settled permanently in England. He erected two houses to make glass in Fernfold Wood, Wisborough Green, and one "fair dwelling house, covered with shingles, and the windows thereof well glazed." He died in his fair dwelling-house, and the Wisborough registers record that "Joh: Carry: Mr. of the Glashouse was bur: at Aufolde May 23, 1572." Carré's share in the glass monopoly patent passed, in 1576, to Peter Appell and Pierre Briet.

A letter from a glass-worker, named George Longe, to Lord Burleigh in 1589 recounts the terms of the monopoly patent granted to Carré and Dolyn in 1567, and also the terms of the agreement between Carré and the Hennezels. He points out that the conditions imposed have not been fulfilled, that royalties have not been paid, that many glass-houses are at work without licences, that the Art has not been effectually taught to Englishmen, and that vast tracts of forest have been wasted. In order to remedy these evils he asks that a monopoly for window-glass be

the full size of the proposed cylinder was re-heated and pinched together into the shape of the figure 8. A pontee was stuck to the centre of the 8, and the opposite end of the bulb was severed from the blowing-iron to be opened to the original size of the pinched end. The diameter of a bulb, which could be pinched in the way described, must have been small, and the marks produced by pinching could only be removed with great difficulty. The process, however, could be carried out by two men. If a third man were employed the pinching of the cylinder could be eliminated and a much larger sheet of glass produced.

[1] Saffre possibly same as "saphora" a form of alkali: see *Taxation of English Glass in Seventeenth Century*, by Francis Buckley, "Barillia or Saphora," p. 21.

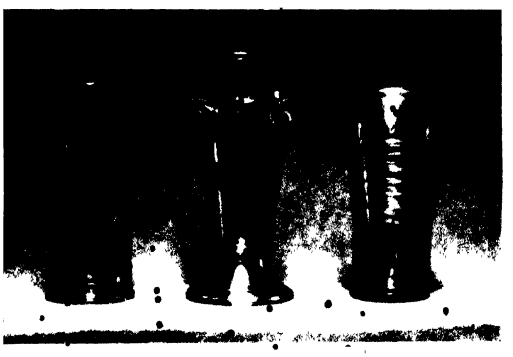
granted to him, equal in every respect to that granted to Carré and Dolyn. If his petition be granted, he will reduce the total number of glass-houses in England from fourteen or fifteen to four, but will erect others in Ireland, where every glass-house will be as good as a garrison of twenty men; he will find work for all the "poor strangers" who may be displaced, and will teach Englishmen the art of glass-making. In place of royalties he will pay a fixed rent on each glass-house, and will put in sufficient security not only to perform all things concerning the patent, but also to repair his "Honor's buildings from tyme to tyme with best glass during the term of the said patent." George Longe in his petition stated that he was a glass-worker himself and it is possible that he may have been connected with Henry Longe, who had a small holding in Chiddingfold in 1542. He started one or more glass-houses in Ireland, but the result of his petition is unknown.

The introduction of glass-workers from the Low Countries and France by Carré had a far-reaching influence on the English glass industry. The names of the first comers and their descendants, often strangely mutilated, can be traced in church-registers in Surrey, Sussex, Hampshire, Gloucestershire, Worcestershire, in Newcastle and in London. Their wanderings were guided by the attraction of fuel, first in the form of beech woods, and latterly of coal, and by the existence of settlements of co-patriots and co-religionists. They have left traces behind them consisting of the foundations of furnaces and ovens and scrap-heaps containing fragments of crucibles as well as of window-glass and vessels. Furnace-foundations have been found near Chiddingfold, Surrey, at Buckholt near Salisbury and at Woodchester near Stroud. A reference to the Buckholt glass-house is found in Sir Robert Mansell's summary of the history of glass-making in England. Writing towards the close of the reign of James I, he says: "Buckall, within six miles of Salisbury being a wood of great content was wholly consumed by glass-makers." A site in Buckholt farm, always known as the Bottle-factory, was excavated in 1860. The foundations of a rectangular brick-built furnace were found, and also of four smaller furnaces or ovens, one at each corner of the main furnace. These may have been used for annealing the finished glass, baking crucibles, burning beech-wood for ash, or for the preliminary melting of the glass mixture. Amongst the fragments of glass discovered on the site were feet of beakers with wide tubular

Fig. 20. Fragments dug up on the site of a sixteenth century glass-house in Gloucestershire.

1 and 2. Feet of goblets, showing hem and kick-up.
3. Base of tumbler, showing rig-a-ree decoration of base.
4. Threaded decoration on tumbler.
5 and 6. Parts of a raised Vandyked line on tumbler.
7. A glass "prunt" or seal for decoration.

Fig. 21



A B C

Fig. 22

Figs. 21 and 22. Reproductions from fragments dug up on the site of a sixteenth century glass-house in Gloucestershire. A, Tumbler with base decorated with rig-a-ree ring. B, Goblet with Vandyked line of ornament. C, Tumbler with threaded decoration.

hems and the base of a square-bottomed tumbler with a beaded edge (Fig. 20, 2 and 3).

The Woodchester site was discovered and has been excavated by Mr Basil Marmont, who has a large collection of fragments of crucibles and glass. The plan of the furnace is circular, an important constructional improvement. In all the scrap-heaps the window-glass fragments are, with few exceptions, of a greenish tint and of broad or sheet-glass. Associated with the fragments of flat glass found at Chiddingfold, flakes of flint, like arrow-heads, have been found which were undoubtedly used for marking if not for cutting the sheets of glass. It has been possible to build up some of the drinking vessels from their fragments: there are two principal types: the square-bottomed tumbler with a beaded cord running round the edge of the base (Fig. 22, A), and the straight horn-shaped goblet, with an open spreading, widely hemmed foot (Fig. 21). These two types have been found at Chiddingfold, Buckholt and Woodchester, and there are specimens in the Guildhall Museum, London, and in the Syer Cuming collection in Southwark. In the Woodchester scrap-heap a fragment of a goblet has been found with a trailed or looped band of dark green glass running round the bowl, reminiscent of the simpler trailed decorations on Anglo-Saxon and Roman vessels (Fig. 20, 5 and 6 and Fig. 22, B). Associated with the fragments of vessels are many ornamental bosses or "prunts" (Fig. 20, 7), which have been broken out of vessels, as well as curious toadstool-shaped solid glass implements for which it is difficult to assign a use. They may have been used for smoothing cloth or linen, or for holding and spreading out lace or other fine fabrics for darning. There are also pieces of flat, deeply ribbed, wine flasks (Fig. 19), which may have been intended to imitate the flat wicker-covered bottles in which some foreign wines were imported. In addition to furnaces and fragments the foreign glass-workers left their names in documents and registers, and it will make the story more clear if these references are set out in a chronological table. For information on this subject we are chiefly indebted to Sydney Glazebrook's *Collection for a Genealogy of the noble families of Henzey, Tyttery and Tyzack*, printed in 1877, and to the Rev. A. W. Cornelius Hallen's contributions on the same subject to the *Scottish Antiquary* of April, 1893.

CHRONOLOGICAL TABLE

1568. Thomas de Hennezel, Balthazar de Hennezel, of the glass houses of the Vosges. Lansd. MS. No. 76. Letter enclosed by Becku alias Dolyn to Sir W. Cecil.

1572. Joh. Carry of the Glasshouse, buried Aufold. Register of Wisborough, Sussex.

1576. Jan. de Tisac, Pierre Vaillant, Claude Potier, ouvriers de verre à la Verriere de boute haut.
1577. Mr de Hennese et son fils Louis de Hennesey, Arnoul Bisson, Jan Perne, Jan Bure, tous de bocquehaut.
1579. Mr de Hou, Verrieren de bouquehaut.
Registers of l'Eglise Wallonne de Southampton, containing lists of those who made profession of faith and were admitted to Holy Communion, printed for the Huguenot Society.

1581–1600. The names, Henzy, Tyttery, Tyzack, Bongar, Cockery (Caqueray), and the marriage of John Tizacke, alias Burrye, to Mary daughter of Peter Bongar.
Registers of Wisborough, Sussex.

1589. Anthony son of Peter Boungar buried. Register of All Hallows, London Wall.

1599. John Pillney, buried, a Frenchman of the Glass-house; Abram Tyzack son of a Frenchman at the Glass-house, baptised.
1601. Anthony Voydyn, glass founder, buried.
Registers of Newent, Gloucestershire.

1612. John son of Paul and Bridget Tyzack, baptised. Register of Kingswinford, Worcestershire.

1615. Paul son of Jacob Henzie, Zacharias son of Fowler Henzie, baptised.
1621. Edward Henzey of Amblecote, broad-glass-maker, died.
Registers of Oldswinford.

1619. John Tesswicke son of Timothy Tesswick, glass-maker, a Frenchman, baptised. Register of St Nicholas, Newcastle-on-Tyne.

1619. Isaac Henzey, glass-maker; Jacob Henzey.
1620. Samuel Tizick, glass-maker; David Tyttere, glass-maker.
1625. Daniel Henzey, broad-glass-maker; Perigrine Henzey, broad-glass-maker.
1631. Tubal Crissom, workman at the Glass-house.
1647. Robert Tyzick, broad glass-maker.
Registers of All Saints, Newcastle-on-Tyne.

1636. Jacob du Houx, buried. Register of All Hallows, London Wall.

1679. Lease to Jacob Henzey, William Tizacke and Daniel Tittery of the Western glass-houses.
1684. Lease to John Henzell, Peregrine Tyzack and others of the Eastern Glass-houses.
Orders of Common Council, Newcastle-on-Tyne.

1684. Memorial to Timothy Tizack and Elizabeth his wife, with the motto "Seigneur je te prie garde ma vie." Gateshead Parish Church.

1691. Gift by Paul Henzey of Amblecote to parishioners of Old Swinford and Stourbridge of a silver Communion Cup bearing the motto "Seigneur je te prie garde ma vie." Church-wardens' book, Oldswinford.

1738. Joshua Henzey, the younger, of Amblecote, died. Register of Oldswinford.

VENETIAN INFLUENCE, 1549–1592

In order to follow the development of glass-making in England it is necessary to shift the scene from the woodlands of Surrey and Sussex to London. Venetian drinking glasses had found their way to England in the fourteenth century. Thus it is recorded that in 1398 safe-conduct

Fig. 23. JACOB VERZELINI.
From a brass in the choir of Downe Church, near Orpington, Kent, dated 1606.

was granted by King Richard II for two Venetian galleys to enter the port of London and permission was given for the sale on board of small wares, namely glass vessels and earthenware.

The demand for Venetian glasses steadily increased, they were stored in the great houses and were accounted equal in value to vessels of silver. Henry VIII had a collection, and some of his glass cups were harnessed in gold.

Many attempts were made by speculative merchants to induce

Venetian glass-blowers to settle in England and to teach Englishmen the refinements of their craft. In 1549 eight glass-blowers of Murano left Venice on account of slackness of work, made their way to London, and entered into a contract to make drinking glasses of Venetian design and material in London. The names of the eight were Iseppo Casseler, Marco and Piero Terribile, Gracioxo, alias Disperato, Baptista da Chiari, Alvixe di Albertino, Hieremia Pixani and Sebastian Zanon. It is known

Fig. 24. The wife of JACOB VERZELINI.
From a brass in the choir of Downe Church, near Orpington, Kent, dated 1606.

that they worked near the Tower and it is probable that their factory was established in the dining-hall of the House of the Crutched Friars, in Aldgate, which had been surrendered in 1539. Stow, writing in 1598, said the Friars' hall was made a glass-house, where drinking glasses were made. The hall was certainly used by Jacob Verzelini as a glass-house in 1573. The eight Venetians, on being recalled to Venice by the Council of Ten, attempted to break their contract, but were detained in the Tower. They obtained permission from the Council to remain in

Fig. 25. Crystal glass with slightly brownish tint, hollow moulded "knop," and two horizontal lines of enamel. Diamond point etching. Made by Verzelini, probably at the Broad Street works. Dated 1586. British Museum.

London sufficiently long to fulfil their undertaking and in 1551 with the exception of Iseppo Casseler they are reported to have returned to Venice. Casseler entered into partnership with Thomas Cavato, from Antwerp, and continued to make glass, probably in Crutched Friars, until 1569.

Jacob Verzelini, who was also connected with Antwerp through his wife, had commenced work in the Hall of the Crutched Friars before 1573 and remained there until 1575, in which year it was destroyed by fire. Venetian drinking glasses may, therefore, have been made in this Hall almost continuously from 1549 to 1575. Verzelini, apparently, moved

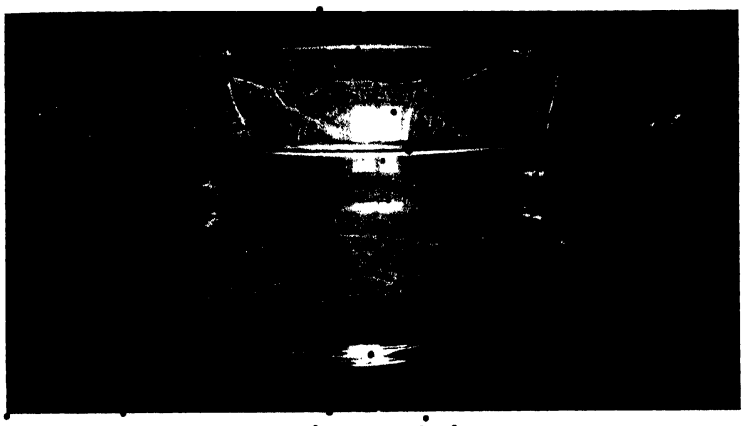


Fig. 26. Colourless crystal bowl; 1⅞ inches diam., 4½ inches deep, with diamond-point etching; attributed to Verzelini. London Museum, Lancaster House.

his works to a site at the eastern end of the Church of the Austin Friars in Broad Street, although he continued to live near his old factory.

Little is known of Verzelini beyond what is told by the memorial brass plate embedded in the chancel floor of the little church of Downe in Kent. It bears the engraved portraits of Jacob Verzelini, Elizabeth his wife, and of several children, graduated in size, all stiffly robed in Jacobean costumes, and records that Jacob was born in the City of Venice and died in 1606, aged 84, and that his wife Elizabeth, of the ancient houses of Vanburen and Mace, died in 1607, aged 73. According to the Patent Roll of Elizabeth, 15 December 1575, a special licence was "granted to James Verselyne a Venetian, inhabitinge within oure cittie

of London, who hathe sette uppe within oure said cittie one furneys and sette on worke dyvers and sondrie parsonnes for the makynge of drynkynge glasses suche as be accustomablie made in the towne of Morano." The usual conditions are inserted: the licence is for twenty-one years: the drinking glasses are to be as cheap or cheaper than those commonly imported: no similar glasses are to be made within the Queen's dominions by other glass-makers, or to be imported, and Englishmen are to be taught the craft.

Fig. 27. Two figures from a picture by Samuel Moore of the Coronation Banquet held in Westminster Hall, 23 April 1685. "Moore flourished about 1715," Bryan's *Dictionary*.

If no Venetian glasses were imported during the period of the licence, there are several glasses and fragments of glasses of distinctly Venetian type which must be attributed to Verzelini's city glass-house. A characteristic is the deeply ribbed hollow "knop" or boss in the stem, and some of the more costly pieces are decorated with diamond-point etching. There is a green wide-bowled tazza (Frontispiece) belonging to Mr Wilfred Buckley, which was given by Lady Georgina Smythe to Horace Walpole. It is decorated with diamond-scratched scrolls, and bears the date 1580 and the initials A. F. An almost colourless goblet (Fig. 25) in the British Museum

is similarly decorated and bears the date 1586, the initials G. S. bound together by a true-lovers' knot, and the words "In God is all mi trvste." The bowl is encircled by two parallel bands of colourless glass and by two fine lines of white enamel. These glasses show very advanced technique and appear to be made, as Venetian glasses are made, of soda-lime glass.

Samuel Moore's picture (Fig. 27) shows that drinking glasses of Venetian type were in use up to the end of the seventeenth century.

In 1592 the Broad Street works were taken over by Sir Jerome Bowes, and later passed into the hands of Sir R. Mansell.

INTRODUCTION OF COAL AS FUEL: MANSELL'S *RÉGIME*

Sir Jerome Bowes (Jeromimus Bowes, Miles), who succeeded Verzelini in 1592, was a man of some distinction, and Pepys refers to the bold front he exhibited to Ivan the Terrible, on the occasion of his embassy for Elizabeth in 1593. He exercised the privileges of his monopoly and it is recorded that in 1598 he compelled a Frenchman, named Hoe, to close a glass-house in Gloucester where he was making a great quantity of glasses without a licence. In 1607–8 at the end of the term granted to Bowes the monopoly for making drinking glasses passed to Sir P. Hart and Edward Forcett. In 1611 a patent was granted for the construction of glass-furnaces to burn coal and in 1612 a monopoly was granted for making all kinds of glass, using coal for fuel, to Sir Edward Zouch, Bevis Thelwell and others, including Thomas Mefflyn who appears to have been the expert and who was succeeded in 1614 by Robert Kellaway. The rights of Hart and Forcett, however, were safeguarded. In 1615 the use of wood as fuel for glass furnaces was forbidden by proclamation. In 1613 a report had been made to the king on the quality of the glass made in a factory, recently erected in Lambeth by Zouch and Thelwell, where Scotch coal was used. The glass was pronounced to be "generally good and clear but occasionally uneven and full of spots."

Sturtevant in his *Metallica*, 1612, complains of no such defects in the green glass for windows melted in a "wind" furnace with pit coal as fuel at Winchester House, Southwark. It is probable that the spots of Zouch's glass were due to the action of the reducing atmosphere of coal fire on the lead flux contained in the mixture for mirror-plate glass. No such flux would be used in the mixture for green window-glass. It

may be suggested that dome-shaped, covered, crucibles were introduced to protect the mirror-plate glass mixture from the reducing action of the fire, and that the loss of heat due to the substitution of covered for open crucibles led first to the use of increased proportions of lead flux to increase the fusibility of the glass mixture and to the gradual development of the glass now known as English flint-glass. The total replacement of carbonate of lime by oxide of lead, whether in the form of litharge or red lead, was not, as claimed by Mr Hartshorne, the result of a sudden invention by Powlden, or Tilston, or Ravenscroft, but of successive tentative experiments to make a more readily fusible glass. The use of the carbonate or oxide of lead as a glass flux is referred to in Neri's *Art of Glass* published in 1611 but the perfected flint-glass, composed of sand, lead and potash, probably only dates from the middle of the eighteenth century.

By the year 1618 Sir Robert Mansell, who had been one of Sir Edward Zouch's colleagues, had acquired by purchase the whole interest of the glass monopoly. Robert Mansell (1573–1653), son of Sir G. Mansell of Margam in Glamorganshire, was knighted by Elizabeth for serving with distinction at the siege of Cadiz, and afterwards became Admiral of the Narrow Seas and Vice-Admiral of the Fleet. In Parliament he represented, first, King's Lynn, and subsequently Carmarthen County. He married Elizabeth Roper. In 1639 he dates one of his many letters in defence of the glass monopoly from "my house at Greenwich." The monopoly was a constant subject of controversy, repeated petitions being made for its suspension or repeal. His chief assailant was Isaac Bungard (Bounger), window-glass seller of London, who complained of the quality and price of the window-glass sold by Mansell's agents. A certificate in favour of the glass was given by the Glasiers' Company, but Inigo Jones reported it to be "mixed, good and bad, and very thin in the middle." Mansell accused Bungard of interfering with his supplies of fire-clay and of Scotch coal, and of enticing his workmen to leave him. These charges were to a certain extent substantiated and the stoppage of the supply of Scotch coal for the London glass-houses led to the substitution of coal from Newcastle. The decision to use Newcastle coal in the London glass-houses was made by Lady Mansell who acted as director of glass-factories whilst her husband was engaged abroad in the king's service. There were

factories using coal for fuel, established or licensed by Mansell, in London, Newcastle, Stourbridge, Swansea, the Isle of Purbeck, King's Lynn, Milford, Newnham and Awsworth. Amongst the glass-houses in the London district were one in Broad Street for Venetian drinking glasses, formerly used by Verzelini, one in Lambeth for mirror-plate, and several for window-glass and bottles.

In 1618 James Howell (*Epistolae Hoelianae*) wrote to his father from the Broad Street works,

> Sir...The main of my employment is from that gallant knight, Sir Robert Mansell, who, with my Lord of Pembroke and divers others of the prime Lords of the Court have got the sole patent of making all sorts of glass with pit coal...and the business being of that nature that the workmen are to be from Italy and the chief materials from Spain, France and other countries, there is need for an agent abroad for this use, so that I believe I shall have employment in all those countries before I return. Had I continued still steward of the glass-house in Broad Street, where Captain Francis Bacon has succeeded me, I should in a short time have been melted away to nothing amongst those hot Venetians.

In 1621, 27 March, he says:

> I am now, thanks to God, come to Alicant in Spain, for I am to send thence a commodity called Barillia for making crystal glass, and I have treated with Signior Andriotti for a good round parcel of it to the value of £2000. This Barillia is a strange kind of vegetable...a thick earthy shrub that bears berries like barberries. When ripe they dig it up by the roots and stack it in cocks like hay to dry. When dry they place the shrubs in a trench and set fire to them. The pit is closed and when, after some days, it is opened, the Barillia juice is found turned into a blue hardstone.

In a letter addressed to the Honourable Sir Robert Mansell, Vice-Admiral of England, dated from Venice, 30 May 1621, he says, "these two Italians, who are the bearers hereof, by report here are the best gentlemen workmen that ever blew crystal. One is allied to Antonio Miotti, the other is a cousin of Mazalco. I have written to Captain Bacon." In describing a visit to Murano, he speaks of the glass made there as "chrystal."

It is difficult to assess the advantages of Mansell's *régime*. The saving of timber consequent upon the universal adoption of coal for melting glass was an undoubted advantage. The community benefited by the establishment of window-glass and bottle factories in many parts of the country, where previously supplies of glass could only be obtained with difficulty. The monopoly may have equalised the quality of the glass throughout the country, but there is no proof that there was any special

development of artistic craftsmanship. The claim, however, of the Duke of Buckingham in his petition to the king in 1663 for a renewal of the patent, that "the manufacture of looking-glass and Coach plates was not known or heretofore used in England" need not be accepted as proving that Mansell had failed in this branch of glass-making.

George Villiers, 2nd Duke of Buckingham (1628–1687), whom Dryden described as "chymist, fiddler, statesman and buffoon," when the influence of chemistry was in the ascendant, became owner of works in Vauxhall, Lambeth, for making mirror-glass and coach-plates, and secured the service of a company of Italian glass-makers under Rosetti. These works were visited by Evelyn in 1676: "saw the Duke of Buckingham's glass-works, where they made huge vases of mettal as clear ponderous and thick as chrystal." In the Reminiscences of the Rev. Dawson Warren, Vicar of Edmonton, it is stated that John Dawson, who died in 1712, was taken as an apprentice by the Duke of Buckingham in 1680 and subsequently became manager of the Vauxhall glass-works.

The patents granted to Clifford and Powlden, to Tilston and to Ravenscroft for improvements in the manufacture of crystal-glass, between 1660 and 1674, were probably rather for variations of the original mixture than for inventions. It is doubtful whether any of them refer to the use of oxide of lead except possibly as a flux. The object was to produce a perfectly colourless glass and the methods employed were the gradual substitution of potash for soda and the use of purer forms of silica. It is known that Ravenscroft's glass at first was liable to crizzling: a defect not uncommon in a lime-potash-soda glass. For silica Ravenscroft used a pure sand from Maidstone and sometimes mixed with it finely powdered calcined flints. Houghton, in letter No. 196, 1696, says, "I remember when Mr. Ravenscroft first made the flint glasses." Ravenscroft in 1674 was working at a glass-house in Henley-on-Thames, which belonged to the Glass-sellers' Company, but moved afterwards to their glass-house in the Savoy.

The collection of letters and drawings in the British Museum (Sloane MS. 857) sent by John Greene, glass-seller, of the Poultry, London, to Allesio Morelli, glass-maker of Venice, 1667–1672, shows on how large a scale Venetian drinking glasses were imported, and the fashion and character of the glasses then used. It would appear that after Mansell's death, in 1653, the supply of English drinking glasses had fallen off both in quantity and quality.

CHAPTER III

CONTEMPORARY RECORDS OF GLASS-MAKING IN ENGLAND, 1567–1700

THE following particulars have been extracted from the *Calendar of State Papers Domestic*, *The London Gazette*, *Journals of the House of Commons* and other sources.

1567. Letter from Pierre Briet and Jean Carré to Cecill asking permission to erect glass-works similar to those of Venice.

Petition of certain foreigners to Cecill that he will procure a licence for establishment of a manufactory of glass for glazing.

John Quarre (Carré) states that the aforesaid foreigners will pay duty for the glass manufactured.

Proposals of Anthony Becku, alias Dolin and John Quarre for establishing a manufactory for table-glass.

Articles touching the making of glass for glazing within the realm, such as is made in France and Lorrain, agreed on by the Queen with Anthony Becku, alias Dolin, and John Carré (Quarre). S. P. Dom.

1567. De con: Sp: pro J. Carr et aliis. Monopoly for 21 years to make glass for glazinge to Anthony Becku alias Dolin and John Carr. Patent Roll of Eliz.

1568. Anthony Becku and J. Quarre, glass-makers, to Sir W. Cecill, asking permission to cut wood and make charcoal in Windsor great park. S. P. Dom.

1568. A. Becku to Sir W. Cecill complaining about action of John Carré in engaging Lorraine workmen, and enclosing copy of John Carré's contract with the Hennezels. Lansdowne MSS. B.M.

1570 (about). Jacob Versalin, of the glass-house, with wife and five workmen dwelling in Ward of Aldgate. Huguenot Society's Publications. List of Aliens dwelling in City.

1573. Jacob "Varsulme" forbidden to make glass before hallow-tide owing to the amount of wood consumed. Repertories of the Court of Aldermen, London.

1575. De licen: speciali: pro J. Verselyne, 21 years. Monopoly for drynkinge and other glasses as made in Morano. Penalties for infringing licence: 10/- per glass: £200. 0. 0 per furnace: one-half of penalties to go to Crown, one quarter to Verselyne and one quarter to informer: No glasses to be imported. Patent Roll Eliz.

1589. George Longe to Burghley, re glass for glazing: application for licence, Dolyn and Carr's patent having expired. Longe had perfected glass-making in Ireland where he had bought Captain Woodhouse's patent. Lansdowne MSS. B.M.

1592. De Con: Sp: pro Jeromimo Bowes, Miles, for making drinking and other glasses for 12 years from end of Verselyne's patent in consideration of yearly rent of 100 marks. Permission to import Venetian glasses for Noblemen within Her Majesty's Realm. Other conditions similar to those of Verselyne's patent. Patent Roll Eliz.

1592. Special licence to Sir Jerome Bowes, to make drinking glasses in England and Ireland for 12 years on expiration of like licence for 21 years to Jas. Verselyne. S. P. Dom.

1607. Grant to Sir P. Hart and Ed. Forcett, in reversion, after Sir J. Bowes, of the sole making of Venice glasses. S. P. Dom.

1608. Special licence for 21 years, from end of Sir J. Bowes' patent, to Sir P. Hart and Edward Forcett to make drinking and other glasses. Patent Roll James I.

1611. Patent for 21 years to Sir William Slyngesby, Kt. for furnaces to burn sea-coal or pit-coal for melting glass. No one without patentee's permission to set up such furnaces. Patent Roll James I.

1612. Absolute licence to Sir Edward Zouch, Kt., Bevis Thelwell, Thomas Percivall, gent, and Thomas Mefflyn, glasier, to make all kinds of glasses with sea-coal or pit coal, but saving rights of Bowes, Slingsby and others. Patent Roll James I.

1614. Licence for 21 years for making drinking glasses and broad glass with coal, with permission to import glass, to Sir E. Zouch, Bevis Thelwell, Thomas Percivall and Robert Kellaway, vice Mefflyn, together with Sir R. Mansell, Philip Earl of Montgomery and Thomas Viscount Andever for an annual rent of £1000. 0. 0. Patent Roll James I.

1614. Patents for making glass withdrawn in favour of those who undertake to make glass with Scotch coal. S. P. Dom.

1615. The use of wood fuel for glass furnaces forbidden on account of waste of wood. Invention of coal furnace referred to. Importation of glass prohibited. *Proclamation.*

1618. Petition of Sir Robert Mansell, Knight, Vice-Admiral of England, to His Majesty's Most Honble Privy Council, having acquired the whole interest of other patentees, for letters of assistance for pulling down all glass-furnaces erected contrary to the Proclamation. S. P. Dom.

1619. Petition by Paul Virrion for licence to make green drinking glasses in spite of Mansell's monopoly. S. P. Dom.

Answer to same.

1620. Certificate of Inigo Jones that Mansell's glass is mixed, good and bad, and very thin in the middle.

Sir R. Mansell's annual rent for licence for making glass to be £1000. 0. 0.

Import permission to patentee confined to rare and curious sorts of glasses and only until new works are completed.

Mansell's objection to making of looking-glasses by other manufacturers.

John Maria dell' acqua, Venetian glass-worker, said to have been enticed to Scotland from Mansell's works by Agmondesham Pickayes, in Mr. Ward's name.

Complaints about Mansell's glass and replies to same. S. P. Dom.

1621. Bungar's petition for suspense of Mansell's patent. Testimony of Glaziers' Company as to cheapness and quality of Mansell's glass, which is better than Scotch glass, and petition in favour of Mansell's glass.

Order that no glass be imported except from Scotland.

Statement of Elizabeth Lady Mansell, during Sir R. Mansell's absence in service of his country, in answer to Bungar. S. P. Dom.

1623. Mansell's specification: having bought out other patentees and the previous patent being cancelled, a new patent to be granted for making all kinds of glass for fifteen years from 1623. Importation from Scotland and abroad to be allowed but rent to be cancelled. Evidence of glass-sellers looking-glass makers, glasiers and spectacle makers in or near the City of London that Mansell's glass is "perfectlie goode, cleare and mar-

chantable, or rather better than glass formerlie made with wood and that there is sufficient store." S. P. Dom.

1624. Reasons submitted to House of Commons against Mansell's patent.

Reasons for maintaining Mansell's patent.

1. Four thousand natives employed in glass-making and shipping materials and glass.

2. Works with coal furnaces erected in London (Broad Street), Isle of Purbeck, Milford, Nottinghamshire and Newcastle-on-Tyne.

3. Expert strangers brought over from foreign parts to make Morano crystalline glasses, spectacle glasses and mirror glasses: the two latter being new businesses.

4. The use of Newcastle coal in London introduced.

The reasons having been referred by His Majesty to the "Council Board" it was decided to grant to Sir Robert Mansell a patent for the sole making of glass for fifteen years from 1623, without rent; but importation of glass from all parts being allowed. They were influenced in their decision by the following facts: 1, the saving of timber; 2, the use of Newcastle coal; 3, the employment of "40 sayle of ships" and 4000 natives, 500 being engaged in "making, grinding, polishing and foyling looking glasses"; 4, the establishment of broad-glass factories in places remote from London to the great convenience of the public; 5, the improvement in the quality of the glass and the reduction in prices. S. P. Dom.

1639. Suit or petition of Sir R. Mansell to House of Lords in which he refers to the reductions he had made in prices:

Ordinary beer glasses, price reduced from 6/- to 4/- per doz.

Ordinary wine glasses, price reduced from 4/- to 2/6 per doz.

Cristall beer glasses from Venice, price reduced from 24/- to from 10/- to 11/- per doz.

Cristall wine glasses from Venice, price reduced from 18/- to from 7/- to 8/- per doz.

Window glass per case of 180 feet 22/6, except a small quantity made at Woolwich. This petition was sent by Sir R. Mansell from his house at Greenwich. B.M. MSS.

1663. Petition to King by George Duke of Buckingham for renewal of patent for making Cristall-glass with a clause therein for the sole making of lookinge glasse-plates, glasses for coaches and other glasse plates.

The Attorney General reported that the privilege of the sole making of looking-glass plates for fourteen years may by law be granted "if it be a new invencion as the Petitioner affirmes." S. P Dom.

1664. Proclamation forbidding import of looking glasses, spectacles, burning glasses, tubes, etc., in order to encourage home manufacture. S. P. Dom.

1666. Warrant to Navy Commissioners of ordnance to deliver to George Duke of Buckingham fifty bags of salt-petre to prevent interruption and cost in the glass-works lately set up at his expense. S. P. Dom.

1666. Token dated 1666: "York Glass Manufactory."

1663. Warrant for a patent to Thomas Tilston, merchant of London, of sole making of crystal glass and looking glass plates, on surrender of a grant made to Martin Clifford and Th. Powlden the inventors. Patent to Thomas Tilston for fourteen years of the invention of making crystal and other glasses. S. P. Dom.

1664. Incorporation of Worshipful Company of Glass-sellers, with power to make statutes and decrees, to punish abuses and deceits within City of London and seven miles thereof. The letters patent, licences, powers and privilege of Thomas Tilson of London for the sole making of christall glasses and looking glasses not to be affected. The Company undertake to utter vend and sell good and merchantable ware at reasonable prices. The by-laws provide that no person shall sell any glasses, looking glasses, hour

glasses, etc., deceitfully made: that no person shall be a seller and that no person shall make, grind, foyle or case looking glasses who has not served an apprenticeship of seven years.

The Company had a glass-factory at Henley-on-Thames.

History of the Worshipful Company of Glass-sellers.

1667–72. Letters from John Greene, Glass-seller, of the Poultry, London, to Allesio Morelli, glass-maker, Venice, with orders for drinking glasses to be made to drawings and instructions enclosed. Sloane MS. 857 B.M.

1674. Petition of George Ravenscroft to the King for patent for seven years for his invention of manufacturing a sort of crystalline glass, resembling rock crystal, with the undertaking that the price shall not be raised above that for which the glass has been readily sold for the past eight months.

The Attorney-General (Sir F. North), having considered the petition, reported that Ravenscroft's glass was made of ingredients other than those used in other glass-houses in England, and that the invention may be of considerable use as the glasses made thereby equalise if not excel those imported from Venice.

The patent for invention of crystalline glass was granted to George Ravenscroft for seven years. S. P. Dom.

1676. "Wee under-written doe certify that the defect of the flint glasses (made by Ravenscroft), which were formerly observed to crissel and decay, hath been redressed several months agoe, Hawley Bishopp, Samuel Moore."

Samuel Moore was clerk to the Glass-sellers' Company. Hawley Bishopp succeeded Ravenscroft at the Henley-on-Thames Glass-works. S. P. Dom.

1674. Letter to Mr. Ravenscroft by teh members of the Company ordering that the clerk, Samuel Moore, shall be responsible for ordering all glasses to be made at Henley-on-Thames.

1685. John Newark chosen to be Clarke of the Company and to officiate at the Glass-house in the Savoy.

1686. John Greene, citizen and glass-seller, buys from Dalton and Co. green bottles made at our glass-house near unto Rosemary Lane.

History of the Worshipful Company of Glass-sellers.

1683, 16 April. His Majesty being well satisfied of the skill of Henry Holden, Esqre. in the compounding and mixing of mettle (glass) without any noxious ingredients has caused him to be sworn his Servant-in-Ordinary.... These are to give notice that the said Mr. Holden is now making his glasses at his glass-house in the Savoy.

1691, 4 June. "There is now made at the Bear-Garden Glass-house on the Bank-side crown window glass[1] much exceeding French glass in all its qualifications."

1693, 27 February. To be sold all sorts of the best and finest drinking glasses and curious glasses for ornament and likewise all sorts of glass bottles by Francis Jackson and John Straw, glass-makers at their glass-houses near the Faulcon in Southwark and at Lynn in Norfolk. *The London Gazette.*

1695, 12 March. Bill imposing, as War Tax, excise duties on bottles, fine glass, looking glass plates, window glass and other kinds of glass and duty of 5/- per chaldron on all coals water-borne from one English port to another. *House of Commons Journals.*

[1] Mr Francis Buckley suggests that after the Revocation of the Edict of Nantes in 1685 French immigrants had introduced improvements in the manufacture of crown-glass. This might account for the great increase in the manufacture of crown-glass and the practical abandonment of the manufacture of broad-glass. In the middle of the nineteenth century the position was reversed.

1696–7. Petitions for removal of excise duties:

1. Peregrine Henzell, John Henzell, Jacob Henzell, Peregrine Tizack and other glass-makers upon the North side of Tyne.

2. Thomas Cardo, Edward Baughton and other glass-makers of the Stourbridge district.

3. John Bague, John Jeston and other Stourbridge glass makers.

4. John Judges, Richard Jeffreyes and other glass-makers in and about the City of London.

5. William Clifton of Houghton, and Abigail Pilmy of Silkstone in Yorkshire.

6. Peter Thompson, glass-maker of Nottingham.

7. Glass-makers of Gloucester and Newnham.

1696. John Houghton's[1] Letter No. 198, giving a list of glass-houses in England and Wales, was published 15 May, 1696.

GLASS-HOUSES

Place	Bottles	Flint and Ordinary	Flint, Green and Ordinary	Looking-glass plates	Crown-glass and plate	Window-glass	Window-glass and bottles	Totals
London district	9	9	–	2	4	–	–	24
Woolwich	–	1	–	–	1	–	–	2
Isle of Wight	–	1	–	–	–	–	–	1
Topsham, nr Exeter	1	–	–	–	–	–	–	1
Oddam, Somerset	1	–	–	–	–	–	–	1
Chellwood ,,	–	–	–	–	–	–	1	1
Bristol district	5	3	–	–	–	–	1	9
Gloucester	3	–	–	–	–	–	–	3
Newnham (on Severn, eight miles from Gloucester)	2	–	–	–	–	–	–	2
Swansea	1	–	–	–	–	–	–	1
Oakengate, Shropshire	–	–	–	–	–	–	1	1
Worcester	–	–	1	–	–	–	–	1
Stourbridge	5	5	–	–	–	7	–	17
Coventry	–	–	1	–	–	–	–	1
Liverpool district	–	–	1	–	–	–	–	1
Warrington	–	–	–	–	–	1	–	1
Nottingham	1	–	–	–	–	–	–	1
Awsworth, Nottinghamshire	–	1	–	–	–	–	–	1
Near Awsworth ,,	–	1	–	–	–	–	–	1
Custom More ,,	1	–	–	–	–	–	–	1
Newcastle-on-Tyne	4	–	1	–	–	6	–	11
King's Lynn	1	–	–	–	–	–	–	1
Yarmouth	1	–	1	–	–	–	–	2
Silkstone, Yorkshire	2	–	–	–	–	–	–	2
Glass Houghton, nr Ferrybridge	–	1	–	–	–	–	–	1
	37	22	5	2	5	14	3	88

[1] John Houghton's periodical letters on husbandry and trade commenced in 1681.

Other glass-houses at work in the seventeenth and eighteenth centuries:

Bolsterstone, near Sheffield: connected with the name of Blackburn, 1670–1740.

Castleforth, on the Aire: mentioned by Dr Pococke 1750; discontinued owing to failure of coal-mine.

Castleton Bridge, Derbyshire: mentioned in diary of Celia Fiennes, 1697.

Catcliffe, started by persons formerly employed at Bolsterstone: John May, owner 1764.

Hopton Wafers, Shropshire.

Whittington, near Chesterfield. Richard Dixon, who had been employed at the Bolsterstone works, moved to Whittington in 1704.

Extracts from Books of Rates[1] as to materials employed in glass-making:

1642. "Ashes, vocat potashes: Barillia or Saphora, to make glasse: Coales of Scotland at 6/8 the tonne: Smalts 3/4 the lb."[2]

1657. "Ashes called potashes: Barillia or Saphora to make glasse."

1660. "Ashes, vocat potashes: Barillia or Saphora to make glasse."

1690. "Pottashes: Barilla or Saphora."

1696. "Our glassmen, in place of powdered flints, use for best flint glass a fine white sand from Maidstone in Kent and from the Isle of Wight."

"Kelp from Cartagena, Alicante, Tripoli, Alexandria." No. 199, *Houghton's Letters.*

1700, 27 June. "The Mine adventurers do hereby give notice that all persons using Potters' oar, red lead, or lead calcined may be furnished by them at Stillyard with Lytharge...a most profitable commodity for glazing earthenware and making fine glass."

Advertisement in *The Flying Post.*

[1] Duties to be paid on goods imported.

[2] "Smalts" = powdered glass, or enamel, coloured blue by oxide of cobalt.

TECHNICAL TERMS AND OLD WORDS WHICH HAVE SURVIVED

MODERN SPELLING	EXPLANATION	AS USED BY DR MERRET IN 1662
Furnace		
Eye	Centre of grate; hottest part of furnace.	Occhio[1] or lumella; circular opening in 3-storey furnace between melting chamber and annealing chamber.
Siege[2]	Bed of furnace on which the pots (crucibles) rest.	
Tease-hole[3]	Stoke-hole.	
Teaser	Stoker.	
Cavillator	Central block of clay of the concentric rings forming crown of furnace.	Cavalet; iron ring surrounding circular opening between furnace and annealing oven.
Crucibles		
Skittle	Small pot, in shape like a skittle, for melting colours or enamel.	
Jockey	Small pot, which, in the furnace, can ride or rest on the top of a larger pot.	
Glass-blowers		
Chair	Glass-blower's seat.	
Chair or shop	Group of glass-blowers working together.	
Gaffer	Master glass-blower or head of chair.	
Servitor	Chief assistant.	
Footmaker	Second assistant, who, in a wine-glass shop, prepares the feet.	
Taker-in	Boy who carries finished glasses from gaffer to leer or annealing kiln.	
Turn	The period, usually six hours, during which a chair works; there are two turns for each chair in twenty-four hours.	
Move	A piecework term; an agreed number of glasses to be made for an agreed price.	
Process of annealing		
Leer	Annealing tunnel.	Leer.
Leer-pans	Iron pans on wheels for carrying goods through leer.	Fraches.
Shoreman	Man who attends to leer and removes finished goods from the pans.	Saroleman; sarosel is the room in which the saroleman removed finished goods from the fraches.
Weighing-room	Room at end of leer in which goods were weighed for excise duty.	

[1] Occhio = eye, Italian. [2] Siége = seat, French.
[3] Tizzonaio = firebox of a furnace, Italian.

Mixing and melting

MODERN SPELLING	EXPLANATION	DR MERRET
Mixer	Man who mixes raw materials and supervises melting.	Founder; conciator[1].
The found	Time during which the furnace is driven to its greatest heat in order to melt the glass.	
Caulker	Oven in which sand is burnt.	Calcar[2], for preliminary fusion or fritting of raw materials.

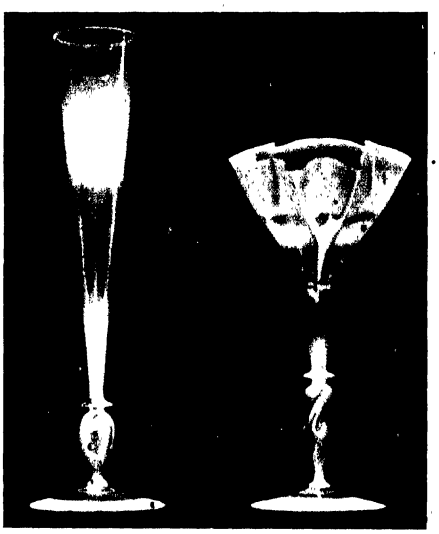


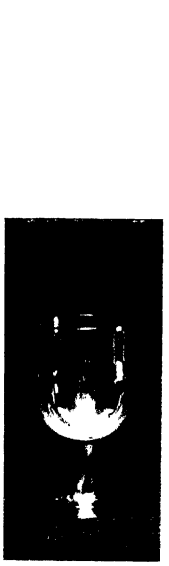
Fig. 28. Vases showing "merese" between bowl and stem (modern).

Linnet holes	Small flues.	Flues connecting furnace with calcar or annealing oven.
Frit[3] or batch	Mixture of raw materials ready for melting.	Mixture of raw materials partially fused.
Sandever or salts	Scum which rises to the top of melted glass, owing to impure materials or improper proportions.	Sandever[4].
Metal	Glass either molten or cold.	
Cullet	Broken glass, especially pieces broken from the ends of blowing-irons.	Collet[5].
Moyls or moils	Small knobs and fragments of glass.	

[1] Conciator = stirrer; concieo, Latin.
[2] Calcaria = lime-kiln.
[3] Fritta = materials for making glass, Italian.
[4] Suint de Verre = grease of glass, French.
[5] Collet = collar, French.

Implements, etc.

MODERN SPELLING	EXPLANATION	DR MERRET
Puntee (ponte)	Iron rod used to hold a glass, by means of a glass seal, while it is being worked.	Ponteglo.
Gadget	A spring-clip, attached to a puntee, to hold foot of wine glass, whilst the bowl is being finished, in order to prevent puntee-mark.	
The tool	A tool, resembling shears, for shaping the blown glass.	"Shears, used for fashioning the glass."



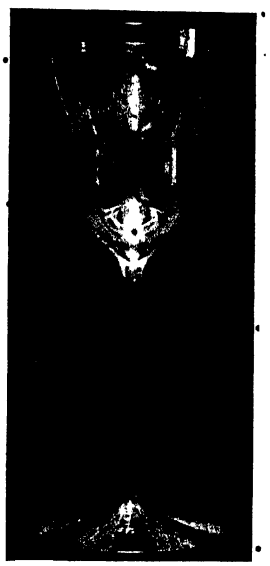


Fig. 29 A Fig. 30 Fig. 29 B

Fig. 29, A and B. Two wine glasses with "stuck shanks," designed by Philip Webb for William Morris, for the Red House, 1859.

Fig. 30. "Straw stem." Stem drawn out of the base of the bowl. Modern, etched with diamond.

Marver	A slab of iron on which the molten glass is rolled after being gathered.	Slab of marble (= marbre, French).
Casher-box	A small triangular iron trough, lined with wood, to hold a finished glass, before its removal to the leer.	"Cassia stake, is that iron, whereon lyeth a piece of wood, on which a glass is placed, whilst being attached to the ponte."
Tower	A block of iron to support the blowing-iron or puntee of a glass-blower working at the furnace.	

Details of Manufacture

MODERN SPELLING	EXPLANATION
Puntee mark	The mark on the base of a glass where it was fixed to the puntee.
Rigaree-marks[1]	Parallel lines on a raised band, tear or collar of glass, produced by ridges on the edge of a small metal wheel.
"Folded" foot or "hem"	The turned-over edge of the foot of a wine glass resembling a hem.
Step	The flattened glass button connecting the stem of a wine glass with its foot.
Merese	A sharp-edged button between bowl and leg of wine glass, or connecting sections of stem or in place of step (Fig. 28).

Fig. 31. Air twist in leg, coarse (modern).

Straw stem	The stem of a wine glass which has been drawn out from the base of the bowl (Fig. 30).
Stuck shank	The stem of a glass, made from a separate piece of glass, and attached to the bowl (Fig. 29, A, B).
Prunt	A seal of glass which may be either plain or moulded (Figs. 3 and 20, 7).
Knop	A glass ball, hollow or solid, forming part of the stem of a vase or wine glass (Figs. 25, 27, 34, 35, 38).
Rib or diamond moulded	Patterns of straight or twisted lines or diamonds impressed on surface of a glass by blowing it, whilst still plastic, in a mould (Figs. 19, 21).

[1] Rigare = to rule lines, Italian.

Details of Manufacture (cont.)

MODERN SPELLING	EXPLANATION
Enamel twist	Twists of fine enamel threads incorporated in the legs or bowls of vases or wine glasses (Fig. 56).
Air twist	Twists of lines of air, formed by the extension of air-bubbles (Figs. 31, 32).
Engraving	Design cut on the surface of a finished glass by pressing it against the edge of a very small, revolving copper wheel (Figs. 31, 32, 33).

Fig. 32. Air twist in leg, fine (modern).

Diamond-point etching	Design scratched by hand on the surface of a glass with the point of a diamond (Figs. 30, 34, 35).
Etching	A mechanical process of applying stencilled patterns to the surface of glasses by the action of hydrofluoric acid.
Frigger	A glass, made as an experiment, to test its effect, or the skill of the craftsman or boy.

WORDS USED SPECIALLY IN CONNECTION WITH THE MANUFACTURE OF WINDOW-GLASS

Journey, Journée	The time taken by the combined operations of melting and working; a fixed number of journeys per week.
Bullion-point	Apex of glass cone or bulb from which a "table" or crown of glass is made.
Bull's eye or Bullion	The mark of attachment of Bullion-point to puntee.
Whimsey	Support for the finished table or crown when being detached from puntee.

Words used specially in connection with the Manufacture of Window-Glass (cont.)

MODERN SPELLING	EXPLANATION
Chevalet	Rest or support for cylinder of sheet-glass after detachment from blowing-iron.
Lagre	Large sheet of glass on which sheet-glass cylinders are flattened or "spread."
Ambitty glass	Glass containing minute opaque specks due to devitrification.

Fig. 33

Fig. 34

Fig. 33. Engraved with copper wheel (modern).
Fig. 34. Etched with diamond-point (modern).

Ponder, Shev, &c.	In the fourteenth century brode-glass was sold by the "ponder" or by the "shev" or "shen." In the fifteenth century coloured window-glass was sold by the "wysp": in the sixteenth by the "bundell." In the seventeenth century, Burgundy glass was imported by the "chest," Normandy glass by the "case" and Rhenish glass by the "way" or "web" containing sixty "bunches."

CHAPTER IV

ENGLISH DRINKING GLASSES

THEIR PROVENANCE AND DATES

THE data available for constructing a reliable record of the provenance and succession of English drinking glasses are so few, and, in some cases, so uncertain, that it is useless to attempt to rival the precise pedigree evolved by Mr Hartshorne and his followers which assigns a date to every variety of form and to every variety of decoration. English potters and silversmiths have always had distinctive marks, but a few glass seals, for instance, those of Ravenscroft[1], are the only glass-makers' marks which are known. Until the end of the eighteenth century the only English glasses of which the provenance can be traced are the fragments dug up on the sites of the sixteenth and early seventeenth century glass-houses in Surrey, Sussex, Hampshire and Gloucestershire, the few surviving goblets and bowls made by Verzelini in his glass-house in Broad Street, and the sealed Ravenscroft glasses, already referred to, which were made either at Henley-on-Thames or in the Savoy. Doubt even exists as to the provenance of the famous "Royal Oak" goblet (Fig. 35), which Mr Hartshorne regarded as "an undoubted example from Buckingham's glass-house in Greenwich"..."the record of which is thoroughly established." The diamond-point etching is admitted to be "probably by a Dutch artist," and no proof is produced that the glass was made in Greenwich. The Greenwich works, it is believed, were established to make mirror-plates, for which brilliant and colourless glass was used, and Evelyn testifies to the Greenwich glass being finer than that made in Murano. The glass, however, of the goblet, is not brilliant, and in colour is a pale greenish brown. It is, moreover, improbable that so delicate a goblet could have been made by glass-blowers accustomed to blow the thick and heavy cylinders from which mirror-plates were made.

[1] Mr Francis Buckley states that sealed glasses were also made at "His Royal Highness' glass-house near Hermitage Stairs, and at the Savoy glass-house of Henry Holden."

The attribution of dates to glasses from dates or references to events inscribed upon them is attended with considerable risk. A glass of earlier date may have been considered a durable and suitable receptacle for a record of an event of later date, and the record of a past event may have been

Fig. 35. The "Royal Oak" or "Festing" goblet. Pale greenish brown with diamond-point etching, light in weight, no brilliancy. From Hartshorne's *Old English Glasses*.

inscribed on a comparatively modern glass. It is, for instance, improbable that many of the so-called Jacobite glasses are contemporary with the events or period which they commemorate. Even a dated coin or medal, actually embedded in a glass, merely proves that the glass has been made

since the coin was struck. In assigning dates it must be remembered that one manufactory may be far in advance of another contemporary manufactory in design, in material and in workmanship. It is quite possible that a glass of which the date and provenance are known may be much later than similar glasses of unknown date and provenance made in another manufactory. It is often assumed that a glass with a simple form of decoration precedes in date a glass with decoration of greater elaboration, but the difference may arise from inequality in skill of the staffs of two glass-houses. Thus about 1880 a glass-house in the

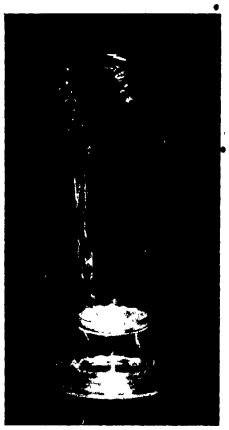


Fig. 36

Fig. 37

Fig. 36. Goblet reconstructed from fragments discovered on site of seventeenth-century glass-house in Gloucestershire.
Fig. 37. Leg of a "Ravenscroft glass" (reputed). London Museum.

south of England produced a series of wine glasses with delicately twisted hollow stems, the manufacture of which required exceptional skill; subsequently a glass-house in the north copied the wine glasses, but substituted solid stems, which required less skill. In this case the more elaborate pattern preceded the less elaborate.

It has been usually supposed that the stem containing air twists preceded the stem containing twists of enamel threads, but it is possible that in a glass-house in which enamel was used for other purposes, enamel twists preceded air twists. It must be remembered that the use of enamel lines for the decoration of drinking vessels was common in

Venice, and that the "Verzélini goblet" in the British Museum (Fig. 38) affords an example of the decorative use of enamel lines in England in the sixteenth century.

The wine glass with a folded foot is said to precede a glass of similar shape with the foot unfolded. The folding of the foot, however, like putting a tuck in a garment, was merely a simple device for reducing the diameter of a foot which had accidentally been blown too large, and

Fig. 38. Verzelini goblet in British Museum, with very fine parallel rings of white enamel.

a glass with folded foot may be contemporaneous with or even succeed a similar glass with a plain foot. In the large collection of working drawings of wine glasses and goblets, which were sent, between the year 1666 and 1672, by John Greene (Fig. 42), glass-merchant of the Poultry, in London, to Morelli, the Venetian glass-manufacturer, there is no indication of a folded foot; and although collectors assert that in ancient glasses the diameter of the foot invariably exceeds the diameter of the bowl, these designs, with very few exceptions, show bowls considerably exceeding the feet in diameter.

In addition to legitimate difficulties in deciding the provenance and date of a glass is the difficulty of distinguishing between genuine glasses and faked imitations. The processes of faking have been brought to such

perfection that it is unwise to accept any glass as genuinely old unless it has a reliable record. Old glasses are now imitated not only in technique, in colour and signs of use, but in chemical composition.

The forms of all drinking glasses have been evolved from two original shapes, namely, the half-sphere (half-cocoanut or cup-shape), and the shape of a straightened cow-horn. Both cup-shaped and horn-shaped vessels appear on the Bayeux tapestry. The steps of subsequent

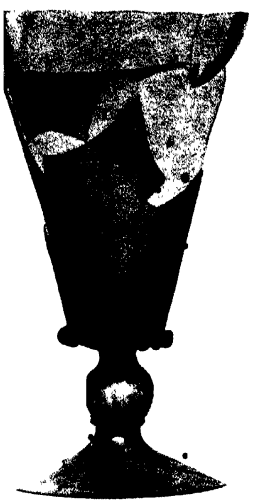


Fig. 30. A pale green goblet, probably made in England, but very similar to one of Greene's patterns (Fig. 42). London Museum.

development of glass drinking vessels were the addition of a foot or base to make the vessel stand upright, the adjustment of the size of the container or bowl to the strength of the liquor to be contained, and the introduction of an extension or stem between the bowl and foot to raise a bowl of small capacity to a convenient height above the surface of the table.

Cup-shaped vessels were probably the earliest drinking glasses, and may have been made even from the time of the Roman occupation, at primitive furnaces hidden in the forests. The majority of the fragments of vessels found on the sites of the sixteenth and seventeenth century

glass-houses in Surrey, Sussex, Hampshire and Gloucestershire may be reconstructed into horn-shaped vessels of two kinds, one with a flat solid foot with an impressed beaded pattern on its edge (Fig. 20, 3 and Fig. 22, A), the other with a hollow tapering base, with folded edge (Fig. 20, 2 and Fig. 21). The total height of the glasses with hollow bases is fairly uniform, but the heights of the bases vary according to the quantity of liquor the bowls were intended to contain. Some glasses for strong liquor are small in diameter, but they probably were found to be too unstable for common use. The glass of which these drinking vessels were made varies in colour from very pale to dark green. The surfaces of both the solid-based and hollow-based glasses are often slightly moulded

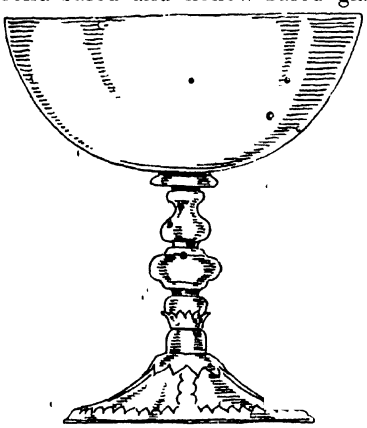


Fig. 40. A glass attributed to Verzelini in Royal Collection, Windsor Castle.

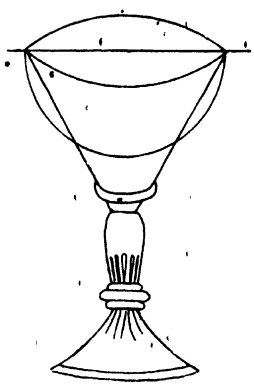


Fig. 41. Diagram of wine-glass of 1621 in Peacham's *Compleat Gentleman*. From Hartshorne's *Old English Glasses*.

in shallow diamonds or with upright or sloping flutes (Fig. 36), occasionally a looped, horizontal line of glass has been applied, reminiscent of Roman technique (Fig. 20, 5 and 6 and Fig. 22, B).

The ancient fragments found on the glass-house sites in the four counties are so similar in material and workmanship that it is almost certain they were manufactured by a succession of craftsmen belonging to the same school and moving in pursuit of fuel from one county to another. These tapered vessels are attributed to the sixteenth and seventeenth centuries, but some of the fragments of vessels of simple form may date back to the end of the fourteenth, for it is recorded that glass vessels as well as window-glass were made in Chiddingfold as early as 1378.

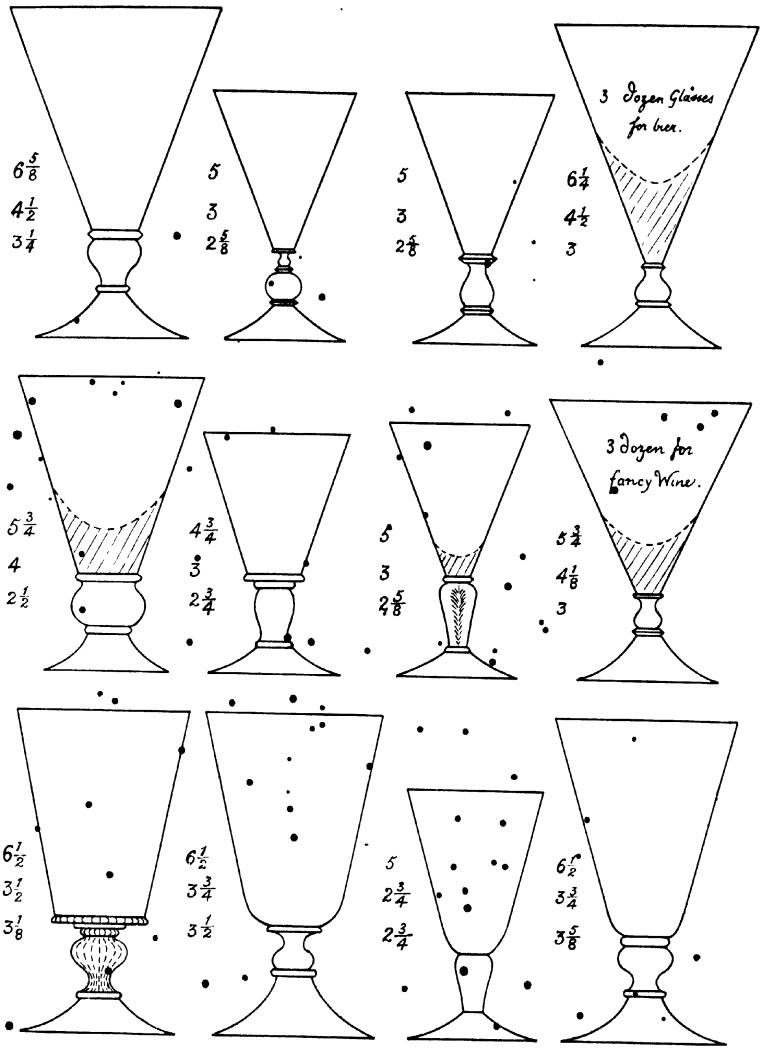


Fig. 42. From Greene's designs in the British Museum. Date: 1666–72. The figures "$6\frac{5}{8}$, $4\frac{1}{2}$, $3\frac{1}{4}$," etc. represent (*a*) height; (*b*) diameter of mouth; (*c*) diameter of foot.

The "Verzelini" goblets which belong to the latter part of the sixteenth century are developed from the original half-sphere or cup form. They are fitted with feet and stems, the latter being built of several sections, of which one is usually a hollow knop (Fig. 40). The bowls are

Fig. 43. Goblet with baluster-shaped, ribbed, stem. Said to have been blown in 1689 for the Rev. Stephen Fornacer in commemoration of the landing of King William III in 1688.
From Hartshorne's *Old English Glasses*.

often decorated with elaborate diamond-point engraving. These goblets, which afford evidence of advanced technique and possess considerable beauty, are too fragile to have been intended for everyday use. The date of the "British Museum" goblet is 1586 (Fig. 38), and the date of Mr Wilfred Buckley's glass is 1580 (Figs. 1, 25 and 38).

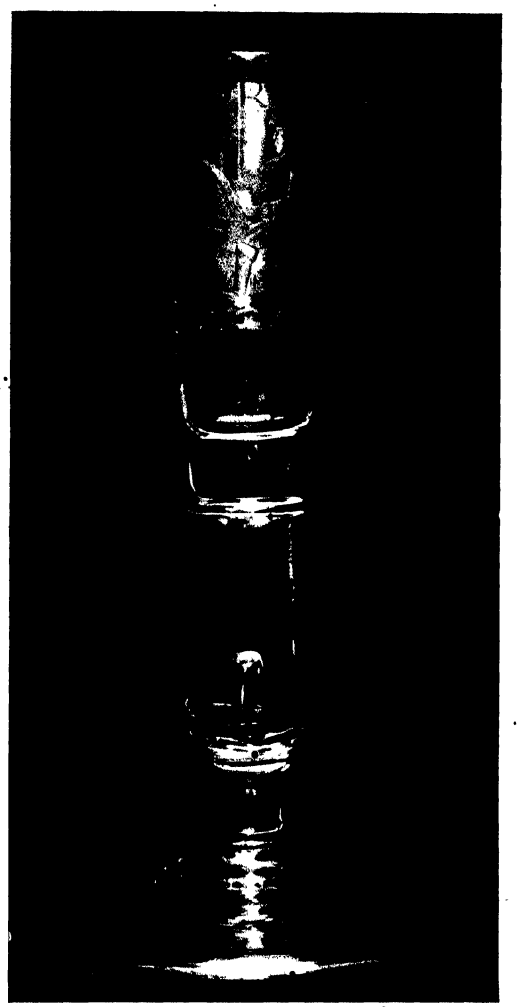


Fig. 44. Wine-glass with built up stem, engraved: "The Glorious Memory of King William," after 1690. Full size.

The real successors of the fragments of horn-shaped glasses, dug up on the sites of sixteenth and seventeenth century glass-houses, are the smaller horn-shaped glasses of the seventeenth century which are fitted with stems and feet. These are represented by the design in Peacham's *Compleat Gentleman* of 1621 (Fig. 41) and by many of the working drawings sent by John Greene to be worked-to in Venice between 1666 and 1672 (Fig. 42). One of these designs shows a sixteenth or seventeenth century tapered vessel with square beaded base mounted on a stem and foot. The stems commencing as a simple button develop gradually to a baluster-shape, solid or hollow, often with one or more subsidiary buttons. The feet are always raised, evidently reminiscent of the raised hollow bases of sixteenth and seventeenth century horn-shaped vessels. The tapered bowls become gradually rounded at the base. The bowls of the Ravenscroft sealed glasses of 1675 are V-shaped with slightly rounded base, and the sealed stems are in shape like short and sturdy balusters (Fig. 37). The glass, which is said to have belonged to the Rev. Stephen Fornacer (Fig. 43) and to have been specially made in 1689 to commemorate the landing of William III, has a tapered bowl with rounded base, a raised foot and a hollow rib-moulded stem of baluster form. English glasses of the second half of the seventeenth century and of the eighteenth century illustrate a long succession of experiments in stem building (Figs. 43, 44, 47, 50). Many of the results are extremely clumsy and show a low standard of technique. Attempts were made with more or less success to conceal irregular bubbles and other defects of workmanship and of material by actually shaping the stem in a mould as in the square-stemmed "Windsor" glass of 1715 (Fig. 46), by moulding the surface of a hollow stem with diagonal flutes as in the William III glass of 1689 (Fig. 43) or by covering the stem with spiral lines, produced by impressing vertical lines in the still plastic glass, and twisting them (Fig. 45). Subsequently cutting was frequently used for the same purpose (Fig. 49).

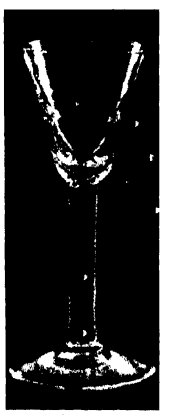


Fig. 45. Twisted-rib: stuck leg. Early 18th century.

A characteristic glass, with composite stem, is shown in Kneller's picture of the "Kit-cat" Club (Fig. 48). As the club was founded in 1688

and the Duke of Newcastle, represented in the picture, died in 1711, the date of the glass is approximately fixed. A print dated 1737 (Fig. 50) contains a glass with V-shaped bowl joined to the stem by a spherical button. Fragments of a similar glass are in the Guildhall Museum. This

Fig. 46. Moulded hollow leg, folded foot, moulded letters and figures "God save King" and "Sayer of Braintree" scratched on it. London Museum—lent by H.M. The Queen. Date: 1715.

shape immediately preceded the glass with V-shaped bowl and drawn stem, the stem being a prolongation of the base of the bowl (Figs. 51, 52, 53, 54). A miniature descendant of the drawn-stem taper glass is still in daily use in the dining-hall of the Inner Temple. If 1740 be accepted as

the approximate date of the drawn-stem taper glass, the decorative use of an artificial tear-shaped bubble in the stem may be assigned to 1740–5 in which period a glass with a stem containing a large tear-shaped bubble was specially made for the great-grandfather of Professor Flinders Petrie (Fig. 55). Directly it was found that bubbles could be made at will, and in any number, by pricking holes in the plastic glass

Fig. 47. From Belfast Tavern Advertisement. Period about 1720. Taper glasses with built-up stems and squat black wine bottles.

and closing them so as to imprison air, bubbles became a definite form of decoration.

The discovery that a long spiral of lines of silvery air could be obtained by extending and twisting a lump of plastic glass, containing imprisoned air bubbles, led to the "air twist" wine glass stem, one of the most fascinating achievements of English glass-blowers. The air-twist stem can either be an extension from the base of the bowl or an attachment to it, and in this respect differs from the enamel-twist stem, which is always made separately and attached to the bowl.

As the "drawn" stem was a distinct technical advance on the "attached" or "stuck" stem, the "attached" air-twist stem probably preceded the "drawn" air-twist stem (Fig. 58).

The stem of the "Pole for ever" glass in the British Museum, which is dated 1754 (Fig. 57), is "attached" and contains a double coil of white enamel lines surrounding a closely twisted air-spiral. This glass

Fig. 48. From Kneller's picture of members of the Kit-cat Club. Taper glass, slightly rounded base and built-up stem. Sir G. Kneller died 1723.

may be earlier than the date inscribed on it, and 1750 may be accepted as the approximate date of the introduction of wine glasses with air-twist stems.

Although the manufacture of "enamel-twist" stems is a more complicated process than that of the air-twist, it is probably earlier, and may have come from abroad. The process is made up of at least six steps: (1st) melting a specially hard enamel which, when embedded in plastic flint-glass in the form of small canes, will not appreciably spread or

widen; (2nd) taking a small lump of enamel from the crucible and pulling it out into a very fine cane; (3rd) breaking the cane into short equal lengths and arranging a number of the lengths perpendicularly and at equal distances round the inner surface of a small clay or iron cup; (4th) gathering on the end of an iron rod a lump of molten flint-glass,

Fig. 49. Jacobite glass with baluster stem, cut square, about 1716. Dates, 1716 and 1745 scratched on glass. National Museum of Antiquities, Edinburgh.

just large enough to fill the interior of the cup, and pressing it down into the cup, so that the lengths of enamel are forced to adhere to the glass; (5th) covering the lump of flint glass, to which the vertical lines of enamel are attached, with a thin layer of flint-glass; and (6th) pulling and twisting the lump to form an enamel-twist rod two or three feet in length. This rod, which contains a simple enamel twist, is cut up into short lengths suitable for forming the legs of drinking glasses. The process and effects may be almost indefinitely varied and multiplied. If

ribbons of enamel are required instead of lines, the enamel lump in the second process must be squeezed flat before it is extended. If the ribbons are to have coloured edges a fine rod of coloured glass must be fixed on either side of the enamel lump before it is squeezed.

A goblet with enamel-twist stem and with oil-gilded engraving on the bowl is said to have been in the possession of the Rev. H. Cantrell, vicar of the church of St Alkmund, Derby, in 1745 (Fig. 56). This glass may have

Fig. 50

Fig. 51

Fig. 50. Taper glass, built-up solid stem. Before 1737. From "The Chearfull Bottle of Ben Bradley," painted by Arthur Pond, first published, April 1737.

Fig. 51. From a painting by Vanderhijen published by T. Bowles between 1745 and 1750.

been imported, but, if it is English, and if the date is correct, the precedence of enamel-twist stems to air-twist stems must be conceded (Fig. 56). Cutting, as a form of decoration for drinking glasses, was introduced from Germany before the middle of the eighteenth century. The thistle-shaped, heavily cut glass (Fig. 100), which bears the coronet and monogram of Frederick, Prince of Wales, father of George III, may be a German importation, but, if it is English, the craft of glass-cutting in England must have been well advanced before 1751, the year in which the prince died.

M. Gerspach, in his *History of the Art of Glass Making*, states that by 1760 English cut-glass was exported to France in considerable quantity. The "Stansfeld" goblets (No. 1, Fig. 101) with cut diamond-

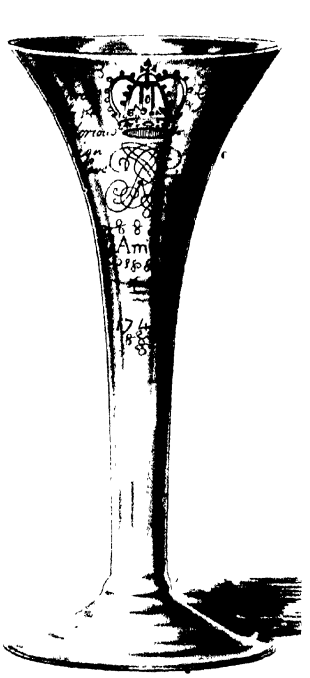


Fig. 52

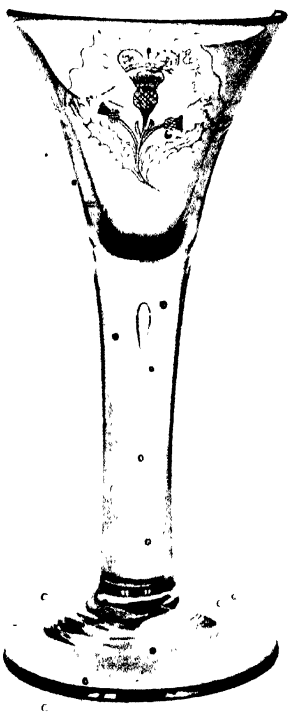


Fig. 53

Fig. 52. Glass with drawn stem, about 1745. From Hartshorne's *Old English Glasses*.
Fig. 53. Taper glass with drawn stem and accidental tear. Crown, thistle and inscription, about 1745. National Museum of Antiquities, Edinburgh.

faceted stems and with cut three-leaved sprays at the base of the bowls commemorate the passing of the Calder and Hebble Navigation Act in 1758[1], which is undoubtedly the approximate date of the goblets.

[1] Mr G. R. Stansfeld, of Field House, Sowerby, in a letter to the author, said: "there is no doubt as to the genuineness of the goblets as they have been in our family since the banquet for which they were made."

Sir Joshua Reynolds' pictures of members of the Dilettanti Society, in one of which several members of the club are represented holding wine glasses, with cut faceted stems, were painted between 1777 and 1779 (Fig. 59, also 60, 61). That cut faceted stems preceded plain fluted stems is suggested by a letter dated October 1804 from Perry and Parker of Fleet Street, designers and makers of cut-glass chandeliers, to Sir Roger Newdegate of Arbury. In submitting an estimate for new chandeliers to harmonise with a chandelier supplied in 1788 they say: "Arms cut with plain flutes have succeeded those cut with facets, and are more generally approved."

Fig. 54. From the frontispiece of *The Spectator*, about 1750.
Wine glasses with V-shaped bowl and drawn stem.

This change of fashion undoubtedly applied to drinking glasses as well as to chandeliers, and may have been due to the improvement in quality of flint-glass and the consequent removal of the necessity to hide specks, bubbles and other defects by breaking the surface of the glass with facets.

We have attempted to trace the succession of the shapes and decorations of English drinking glasses from the fourteenth to the end of the eighteenth century, with the following results:

Simple cups, without feet, belong to the fourteenth century and earlier.

Tapered tumblers, on solid base or raised hollow base, belong to the fifteenth, sixteenth, and seventeenth centuries.

Cup-shaped drinking glasses, on foot and knopped stem, belong to the latter part of the sixteenth century.

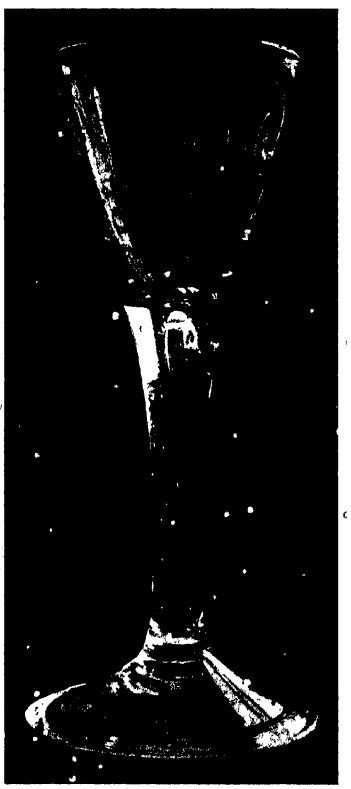


Fig. 55. Folded foot, large artificial tear, about 1740–45. Made for Benjamin Chappell[1] (1698–1770).

Drinking glasses with foot and built-up stem, the base of the tapered bowl becoming gradually rounded, belong to the seventeenth and eighteenth centuries.

[1] Great-great-grandfather of Professor W. M. Flinders Petrie.

In the period between 1730 and 1750 appeared:

1. Tapered drinking glasses with "drawn" stem.
2. Tapered drinking glasses with "drawn" stem and with artificial tear in stem.
3. Drinking glasses with enamel twist in stuck stem.
4. Drinking glasses with air twist in stuck stem.
5 Drinking glasses with air twist in drawn stem.

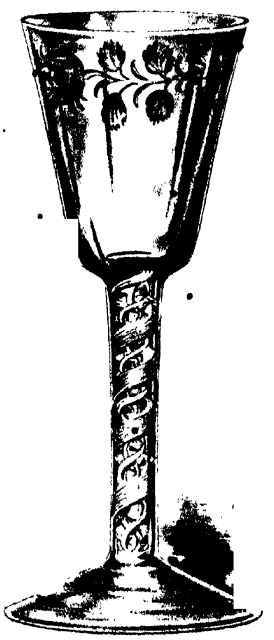


Fig. 56. Glass with enamel twist in stem, formerly belonging to the Rev. H. Cantrell of Derby, about 1745. From Hartshorne's *Old English Glasses*.

The introduction of glasses with cut faceted stems dates from about 1750, and with the stems fluted but not faceted from about 1800.

P.G.

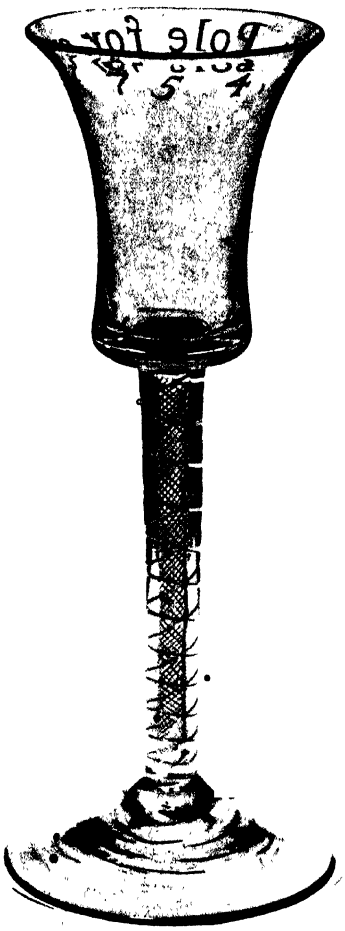


Fig. 57. Glass with air twist within coil of enamel. Before 1754. British Museum.

The squared foot came in about 1770.

This chronology, it must be admitted, is lamentably defective, and

Fig. 58. Jacobite glass with air twist in drawn stem, about 1745–50. The property of G. Robinson, Combe Down, Bath.

in all cases allowance must be made for overlapping. The dates which may be regarded as reliable are:

Fig. 59. Wine glasses with cut faceted stems. From a picture of Members of Dilettanti Society by Sir Joshua Reynolds, about 1777.

Verzelini goblets with knops in stems (Fig. 38)	1570–1600
Peacham's diagram of tapered glass (Fig. 41)	1621
Greene's working drawings (Fig. 42)	1666–1672
The "Fornacer" William III glass (Fig. 43)	1689

Fig. 60

Fig. 61

Fig. 60. Jacobite glass with cut faceted stem, about 1760. British Museum.
Fig. 61. Glass with cut faceted stem, about 1760. From Hartshorne's *Old English Glasses*.

Glasses of the Kit-cat Club (Fig. 48)	1711
Square-leg glass in London Museum (Fig. 46)	1715
The "Cantrell" glass with enamel twist in stem (Fig. 56) ...	1745
"Stansfeld" goblets with cut faceted stems (Fig. 101, No. 1) ...	1758

CHAPTER V

OLD ENGLISH BOTTLES AND FLINT GLASS DECANTERS

"IF you wish to make bottles, this do. When you have gathered some hot glass on the end of a blowing-tube and blown it in the form of a large bladder (*quasi vesicam*), swing the tube with the glass appended to it, beyond your head as if you intended to throw it, and the neck will be stretched by this action: then separate it with a wet stick and put it in the annealing furnace."

Such were the instructions of the glass expert of the thirteenth century. The thirteenth century bottle was merely a bulb with a neck, similar to

Fig. 62. 1657. King's Head and R.R.M. (initials of owner or innkeeper). Height 9 inches. Northampton Museum.

that represented in the fourteenth century picture of Chaucer's[1] doctor of physic. This shape would be suggested by the most rudimentary

[1] Ellesmere MS., *Canterbury Tales*.

Fig. 63. 1660 to 1680. Vintners' Arms and initials R.E.P.

Fig. 64

Fig. 65

Fig. 64. 1685. Crown Tavern, Oxford.
Fig. 65. About 1690. St George and the Dragon.

attempt at glass-blowing, and simple bottles of this kind were probably made at all glass furnaces from a very early date. The constant and ever-increasing demand for bottles for innumerable uses led to the adoption of a succession of devices to hasten production and save labour. The initial bulb was blown into an iron mould to acquire speedily any body-form that might be required. Moulding at first was limited to straight-sided bodies, but by hinging the mould, so that it could be made to shut

Fig. 661 1686, initials C.P. Guildhall Museum.

and open, any form could readily be given. The attachment to the body-mould of one or more movable sections enabled the shoulder and neck to be shaped at the same time as the body, and the uniformity of the mouth was obtained by the use of a hand-tool which moulded the inside and outside simultaneously. Moulds were at first adjusted, opened, shut and reopened by boys, but mechanism was introduced to effect all the necessary movements by the pressure of the workman's foot. Finally, the automatic machine has been evolved which dispenses with mouth-blowing and all manual labour, and performs the whole series of operations,

from gathering the liquid metal to sending the finished bottles to the annealing kiln.

From the middle of the seventeenth century all English wine bottles were made in so-called "bottle-houses" and the glass used for making them was very dark green, amber or black. There were many of these

Fig. 67. 1699. King's Head, Oxford.

1709 1713 1715

Fig. 68.

factories, but it is impossible to assign any particular bottle to any particular glass-house. Nine were in the London district, five in Bristol, five in Stourbridge, four in Newcastle, three in Gloucester, two in Newnham, two in Silkstone, Yorkshire, and many others scattered about the country. In London, Ratcliff was the chief centre of bottle-making,

but, on the south side of the river, there were the Bear Garden works, works near the Old Barge Stairs, and a large glass-house near St Mary Overies, now Southwark Cathedral. Mr Francis Buckley quotes the following extract from "Tracts relating to trade": "in 1695 it was computed that 240,000 dozens of bottles were made in England every year." The bottles were used chiefly for table use, but also, especially in private houses, for storage. In taverns and inns wine and spirits were generally

Fig. 69. 1735. From Hogarth's Rake's Progress. Showing wine bottles and wine glasses.

stored in pipes, rundlets and hogsheads and the contents drawn off into bottles for the use of customers. Improvements had been made in the bulb-shaped bottle: the neck had been strengthened for corking or stoppering by the addition of a glass ring, which also gave increased security for handling, and stability had been given by pushing upwards and inwards the base of the bulb to form the familiar "kick-up" of modern wine bottles. Towards the end of the seventeenth century the kick-up became wide and high so that an apparently generous bottle, although full, might contain an unexpectedly small quantity of wine. Another innovation, suggested possibly by some of the ancient Roman

bottles, was the addition on the shoulder of the bottle of a glass seal impressed with a crest, a badge or the sign of an inn, with, in some cases, a date and initials.

Samuel Pepys on 23 October 1663 went "to Mr Rawlinson's and

Fig. 70. A "Hogarth" bottle, 1735. Victoria and Albert Museum.

saw some of my new bottles, made with my crest upon them, filled with wine, about five or six dozen." These were evidently intended for storage as well as for use on table.

Mr Hartshorne in *Old English Glasses* quotes an entry in the household books of Naworth Castle, of 1624, "19 quartes of seck to fill the

cellars of glasses." The long neck of the original bulb-shaped bottle was at first retained but a squat bottle with short tapering neck was gradually evolved, partly because it was less liable to be capsized and partly because the shortened neck allowed the space between the storage shelves in cellars to be reduced. Fig. 18 (p. 14) shows the interior of a seventeenth century glass-house, with a broken, partly finished squat bottle, lying on the floor. Mr E. Thurlow Leeds has published an interesting paper

Fig. 71. 1757.

(*Antiquary*, August 1914) on the dating of glass wine bottles of the Stuart period. Impressed dates, inn-signs and initials have enabled him to arrange several series of bottles illustrating the changes in form which occurred in decades between 1650 and 1720, so that it is possible by the study of its form to assign an approximate date to an unmarked bottle. The changes took place in the neck, the body, and the "kick-up." The earliest bottle with impressed date belongs to the year 1657 and is in

the Northampton Museum (Fig. 62). The neck is long, the body bulbous and the "kick-up" small. Between 1660 and 1680 the necks are still somewhat long, but the body becomes more angular and the "kick-up" is increased in size. Between 1680 and 1720 the neck becomes shorter and more tapered, and the "kick-up" wider and higher (Figs. 64 to 68).

Fig. 72. One of the "Chastleton" decanters, about 1750. From Hartshorne's *Old English Glasses*.

Squat, wide bottles, although steady and low, were unsuited for storage in large numbers or for holding port wine, which at the beginning of the eighteenth century had gained great popularity. By 1750 a cylindrical bottle had been evolved, very similar to the modern port wine bottle, but rather larger in the body. The cylindrical bottles were

intended for storage and could be stacked horizontally in bins. The use of the black bottle at table is illustrated in Figs. 59 and 69.

The scene from Hogarth's "Rake's Progress," 1735, shows the use of imported wicker-covered bottles as well as of black wine bottles.

Fig. 73. Taper-shaped decanter, about 1770, often engraved with festoons, gilded.

The members of the Dilettanti Society used commonplace cylindrical black bottles together with colourless wine glasses with cut stems (Fig. 59).

The passing of the squat black bottle must be regarded with some regret. It was sturdy, sensible and aesthetically satisfactory. It owed its supersession on the dinner-table to port wine which demanded colourless transparent glass for the display of its colour and for the detection of its beeswing.

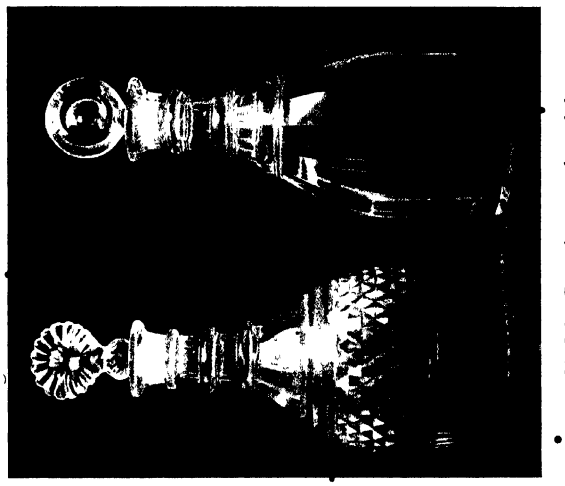


Fig. 75. Sir John Soane's taper-shaped decanters, ith neck rings, about 1780.

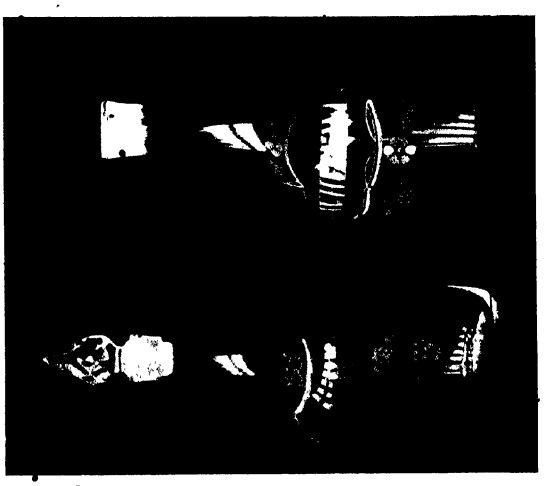


Fig. 74. The "Newdegate" decanters, about 1760.

Fig. 76

Fig. 78

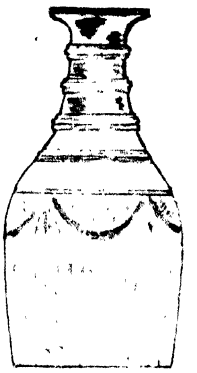


Fig. 77

Fig. 76. The "Tuckey" decanter, by Penrose (Waterford), 1796.
Fig. 77. A Penrose (Waterford) decanter, about 1799.
Fig. 78. Shown at the Great Exhibition, 1851. From the *Illustrated London News*

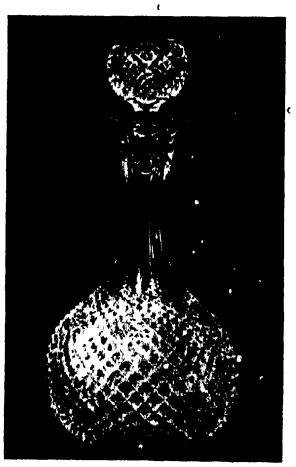


Fig. 79

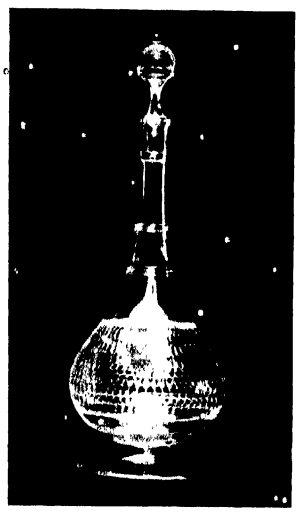


Fig. 80

Fig. 79. Cut decanter, 1860.
Fig. 80. Cut decanter, 1900.

According to Dr Johnson to decant "is to pour off gently by inclination" and a decanter is "a glass vessel to receive clear liquor poured off from the lees." *The Tatler*, 9 August 1710, contains the following advertisement: "At the Flint Glass-House in White Fryars are made and sold all sorts of decanthers of the best Flint." The fashion of using colourless flint-glass decanters for the table in place of black bottles had the effect of introducing the manufacture of wine decanters in flint glass-houses. The earliest flint glass decanters were probably globular with a flattened

Fig. 81. Decanter and wine glasses, designed by Sir T. G. Jackson, R.A. in 1874.

base. The ramous Chastleton decanters are of this form (Fig. 72) and were made for Henry Jones, a zealous Jacobite, who died in 1761. The shape of the Newdegate decanters (Fig. 74) was probably the next development. In these the diameter of the shoulder slightly exceeds that of the base. In the desire for increased stability a decanter was evolved about 1770, tapering gracefully from the neck to a wide base (Fig. 73), and this form, with many modifications, lasted until the end of the century, overlapping decanters with parallel sides. The "Tuckey"

and the "Penrose" decanters of 1796 and 1799 (Figs. 76, 77) are practically parallel-sided, as well as the great majority of the decanters shown in the Waterford pattern-book, 1820–30, illustrated in Mr Westropp's treatise on Irish glass. Social habits changed, the necessity for stability decreased, and by 1851 (Fig. 78) the diameter of the shoulder of a decanter once more slightly exceeded that of the base. Neck rings appear to have been introduced about 1780 (Fig. 75). They were reminiscent of the strengthening ring of the old black bottle, but, except

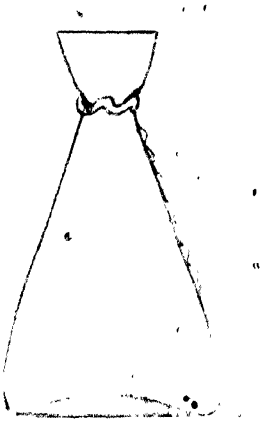


Fig. 82 Fig 83

Fig. 82. Oval claret decanter, without handle. Introduced about 1865. Shape copied from an ancient leather bottle. The oval form makes the decanter easy to hold.
Fig. 83. Flat-shaped, hollow-sided, claret bottle, about 1880.

for retarding the passage of drips[1] of wine from the neck to the dinner-table, served no useful purpose. The necks of decanters were so thick that no strengthening was necessary, and the turned out lip provided security of grip. The rings were intended for decoration and certainly were evidence of considerable technical skill. There were usually three, each ring being single or with one or two parallel mouldings. The single rings were often ornamented with cut facets or diamonds. In 1791 "ten neat 'Rodney' quart decanters with cut rings" were ordered

[1] Late in the nineteenth century a sloping "drip-ring" was placed on claret jugs to guide drips from the lip back to the inside through a small hole drilled in the neck.

from John Dixon, glass-manufacturer of Whittington. The decanters used at the Coronation dinner of George IV had each three neck-rings. In the first half of the nineteenth century the period of decoration for

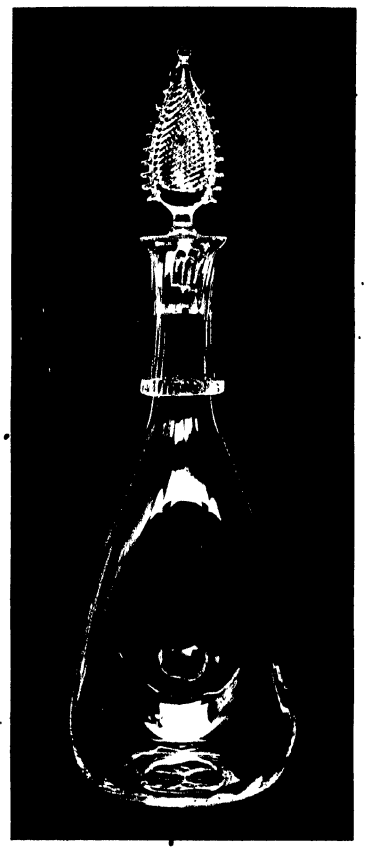


Fig. 84

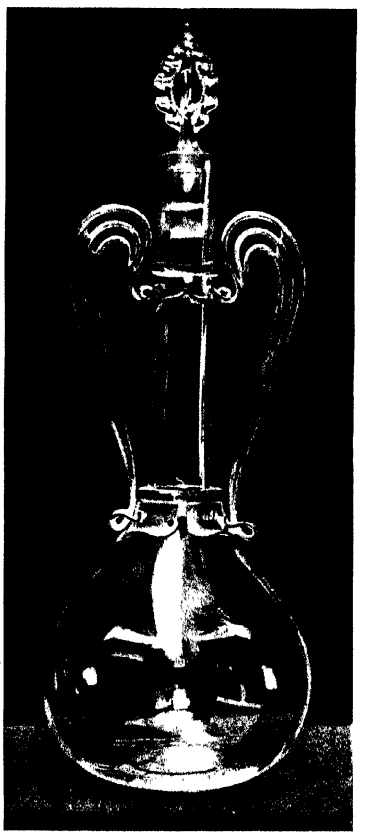


Fig. 85

Fig. 84. "Poppy-head" claret decanter, without handle. Introduced 1880. The four deep dents in the body provide a secure grip.

Fig. 85. Claret bottle, harnessed in silver, about 1900.

display commenced. Decanters grew in height, were often mounted on feet (sometimes square) and lost stability.

Decoration took the form both of cutting and engraving. Both were overdone. The cutting became ever deeper and more ostentatious (Fig. 79), until the craze was checked by the influence of Ruskin and William Morris. From about 1870 a change commenced. Decanters

Fig. 86

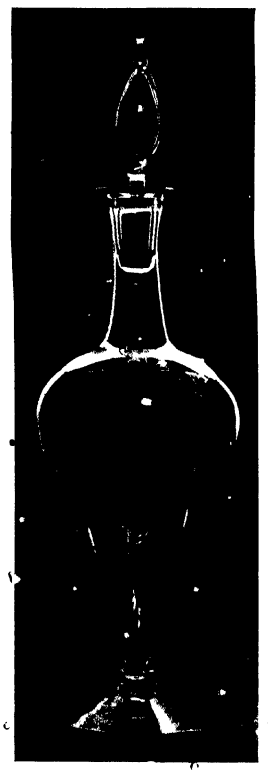


Fig. 87

Fig. 86. Decanter engraved by wheel.
Fig. 87. Decanter engraved by wheel.

became lighter in weight and derived their beauty from a simple graceful outline and sometimes from colour, only sufficient decoration, whether cut or engraved, being added to suggest the brilliancy of the glass and to emphasise the grace of the blown form. Special care was devoted

to designing claret jugs. The glass handle of a claret jug often cracked owing to the claret and the jug being overheated before being placed on the table. Efforts were therefore made to modify the form of the bottle in order that the glass handle might be dispensed with. With the same object claret bottles were frequently harnessed in silver.

At the present time decanters and claret jugs are gradually disappearing from the dinner-table because of the excessive popularity of champagne, just as, at the beginning of the eighteenth century, the black bottle was banished owing to the popularity of port.

From the early part of the last century Yorkshire has been the chief centre of the manufacture of moulded bottles of all kinds, and the names of Alexander, Bagley, Breffit, Kilner and Lumb have become well known. The London district, however, with large new bottle-works at Canning Town, Charlton and Woolwich, may before long become a serious rival for supremacy in output. Cannington Shaw and Co. and Nuttall and Co. at St Helens, and Candlish and Sons at Seaham have important works.

CHAPTER VI

OLD LONDON GLASS-HOUSES

THE title of this chapter is borrowed from a book written by Mr Francis Buckley, whose generous help the author most gratefully acknowledges. In this small volume Mr Buckley has compressed the large amount of information which he has laboriously gathered concerning ancient London glass-houses from the beginning of the seventeenth century to the end of the eighteenth. He justly claims that during that period London was the premier glass-making city in England, and that therefore any facts about the old factories are worth preservation. For his text he has adopted the fourteen place-names connected with glass-making recorded in Strype's, 1755, edition of Stow's *Survey*, but he recalls double the number of glass-houses. Houghton in his letter, No. 198, published in 1696, containing a list of glass-houses in England and Wales, records twenty-six in and about London. The *London Directory* of 1919 gives only seven place-names (four Glass-house Streets, one Glass-house Yard, one Glass-house Fields, and one Glass-house Alley). For convenience, although some overlapping is caused, Mr Buckley has divided his twenty-eight glass-houses into four groups, according to the nature of the glass produced: No. 1, crystal, colourless or flint-glass; No. 2, green glass for bottles; No. 3, glass for windows; No. 4, plate-glass. To make the history of the London glass-houses more complete it is necessary to add some notes about those which are known to have been at work before the seventeenth century, but did not come within the scope of Mr Buckley's book.

It is probable that glass, both window-glass and vessels, was made in London at a very early date, but the earliest established fact is the arrival from Venice in 1549 of eight glass-workers, under contract to make Venetian drinking glasses. It is known that they worked near the Tower, and, when they attempted to break their contract, were detained within its walls. It is not improbable that they established themselves in the quarters subsequently used by Verzelini, the Hall of the Crutched (Crouched or Crossed) Friars in Aldgate ward. The house of the Crutched

Friars had been surrendered in 1539, and Stow says that the site of the church became a tennis-court, a carpenter's yard and suchlike, and the Hall became a glass-house. The eight Venetians, after detention in the Tower, completed their contract and seven of them returned to Venice in 1551. Iseppo Casseler, however, entered into partnership with Thomas Cavato, from Antwerp, and continued to make glass in England until 1569, probably still in Crutched Friars. Jacob Verzelini started work in Crutched Friars some time before 1575, in which year he obtained a monopoly for making Venetian drinking vessels, with the condition that he should teach the craft to the Queen's subjects. Mr H. B. Wheatley, F.S.A., states in *London Past and Present* that the Hall of the Augustinian Priory, Broad Street ward[1], was let to Verzelini, after the Crutched Friars works had been destroyed by fire in 1575. He still continued to live in the Crutched Friars district, for in 1589 an English glass-maker applied for a patent for making "common glasses, such as are not made by Jacob a stranger dwelling in the Crutched Friars." The two Verzelini goblets, which have survived, are dated 1580 and 1586.

The site of one of the earliest seventeenth century glass-houses is still known as "Glass-house Yard, Blackfriars." The position is described by Strype as between the Apothecaries' Hall, St Ann's Church and the King's Printing House, now Printing-House Yard. Mr H. B. Wheatley has discovered two references to this glass-house dated 1607 and 1635. It is possible that this was the factory visited by Pepys and his "cozens" on 23 February 1669, on his homeward journey from the Duke of York's Playhouse, which was near the river on the western side of the Fleet ditch. If they crossed the ditch at Bridewell, they would pass the works on their way eastwards to Seething Lane. The glass objects made for the entertainment of the visitors included "singing glasses of exceeding thinness, which make an echo of the voice." These were probably made of crystal glass. In the immediate neighbourhood, to the north of the Playhouse, in Salisbury Court, was another glass-house, but it is doubtful whether it was working in 1669.

March 1, 1618, is the date of the letter of James Howell, author of *Epistolae Hoelianae*, to his father, in which he describes his position in Sir Robert Mansell's glass-house in Broad Street, where Venetians

[1] Pepys' *Diary*, 24 September 1660: "I went to a dancing meeting in Broad Street which formerly was the Glasshouse."

were at work and pit coal was used for melting the glass. The factory was placed on the site of the east end of the church of the Augustinian Friars in Broad Street ward. Strype, in the 1720 edition of Stow's *Survey*, states that the

> west end of the church having been granted to the Dutch nation, the eastern part (the steeple, quire and side iles of quire) was utilised by the Earl of Wilts for the storage of corn, coal and other household goods....His son, Marquess of Winchester, sold the monuments and paving stones for £100. 0. 0, removed the lead from the roof, and made fair stabling for horses. Here, in the Hall, was a glass-house, where Venetian glasses were made and James Howell, an ingenious man, in King James, the first, his reign, was steward....This place afterwards became Pinners' Hall.

The Pinners' Hall is marked in Ogilby's map of 1677 on the west side of Broad Street[1].

The "Minories" glass-house which stood on the south side of Goodman's Yard, Whitechapel, and the site of which is now covered by large railway warehouses, was the subject of a Chancery lawsuit, Batson *v.* Lewin, which dragged on from 1657 to 1663. It appears before 1651 to have been owned by Bevis Thelwall. Edmund Lewin, who was making bottles in 1677, was succeeded in 1678 by Michael Rackett, who made crystal glass as well as bottles. In 1699 it was owned by "Craven Howard, Esq., and other Trustees:" and drinking glasses were made. In a survey of 1772 this factory is called "Rickets" glass-house.

Another Whitechapel glass-house was that known as "Saltpetre Bank." It stood to the west of Well Close Square, between Well Street and Saltpetre Bank. From 1678 or possibly earlier it was in the hands of the Dallow family. Edward, John and Philip Dallow are mentioned. The latter in 1689 became glass-maker to William III and was granted a patent for making glass "grenado shells." The staple products were green glass bottles, and chemical and garden glass. It is probable that the central factory was amalgamated with several small adjacent glass-houses. In 1741 the scope of the firm was extended and "bottles of all sorts, flint glass, crown or 'sash' glass, and looking glass" were made. Directories give the following successors to the Dallows: 1757, Richard Russell; 1760, Russell and Lawton; 1768, Richard Russell and Son; 1772, Russell and Home; 1793, Russell, Slater and Home. The Precinct

[1] In 1874 the Rev. S. Mayhew exhibited before the Archaeological Society fragments of glass found in Broad Street on the site of Pinners' Hall.

of the Savoy contained two glass-houses in which drinking glasses were made, one, on the river-side, was set up in 1673 by George Ravenscroft, the other, dating from about 1683, was owned by Henry Holden, who was the King's glass-maker. In 1674 a patent for seven years was granted to George Ravenscroft for sole use of "an invention of christoline glass, resembling Rock Christall." John Houghton, F.R.S., writing in 1696, says, "I remember when Mr. Ravenscroft first made his flint glasses." The glass referred to, according to a statement in Plot's *Natural History of Oxfordshire*, was invented by Seignior de Costa, and consisted of a mixture of calcined flints and white crystalline sand with a small proportion of nitre, tartar and borax, the latter ingredient having been added on the suggestion of Dr Ludwell of Wadham College, Oxford. The mixture produced an unreliable glass, and a new mixture was substituted by Ravenscroft, who marked the drinking glasses made from it with glass seals.

A glass-house, known as "His Royal Highness's," producing both crystal glass and bottles was in Red Maid Lane, now Redmead Lane, Wapping. It was near the Hermitage Stairs and in 1684 was owned by the Duke of York. The glasses were marked with a lion and coronet. Glass-house Street, which now runs from Regent Street to Piccadilly Circus, is said to have been first formed in 1679, but at that time extended farther to the west. There must have been a glass-house in or near the site, but its history is unknown.

According to Strype's map of 1720 there were at least three glass-houses near the Falcon Stairs, close to the spot where Blackfriars Bridge now touches the southern bank of the river. Two were in Cockpitt Lane, between Willow Lane and Gravel Lane, and the other a little to the west near the Paris (or Parish) Garden Stairs. By amalgamation of these smaller factories the well-known Falcon glass-works in Holland Street were formed which survived until 1878. According to the *London Gazette* Francis Jackson and John Straw, owners of "certain glass-houses" near the Falcon in Southwark, were making in 1693 "all sorts of the best and finest drinking glasses and curious glasses for ornament and likewise all sorts of glass bottles." The references to the subsequent owners are somewhat confused: Hughes and Winch, 1752; Hughes Hall and Co., 1760; Stephen Hall and Co., 1765–80. In 1781 Hall moved to the Whitefriars glass-works on the other side of the river. In 1768

William Barnes and Co. owned "a glass-house near the Falcon Stairs." This firm was succeeded in 1774 by Cox and Farquharson, in 1781 by Daniel Cox, in 1792 by Alexander Thomas Cox and Co., and in 1803 by Green and Pellatt. These dates and names, however, do not exactly coincide with those given to the author in 1918 by Mr T. Rickman, grandson of Apsley Pellatt. According to Mr Rickman, Apsley Pellatt took over the Falcon glass-works in Holland Street from Cox and Co. about 1790. He was succeeded by his son, Apsley Pellatt, who retired from business in 1852 and entered Parliament. The works were carried on by Frederick Pellatt, brother of Apsley Pellatt, number two. J. Pellatt-Rickman, grandson of Apsley Pellatt, number one, joined Frederick Pellatt in 1868, moved the works from Holland Street to Pomeroy Street, New Cross, in 1878, and gave up glass-making in 1895.

The high reputation of the Falcon glass-works for fine glasses and fine work was mainly due to the enterprise of Apsley Pellatt the younger, author of *Curiosities of glass-making*, a book based on lectures delivered at the Royal Institution and published in 1849. In this factory Faraday carried out some of his researches for the improvement of optical glass, which are described in the *Transactions of the Royal Society* for 1830. In the exhibition of 1851 Pellatt and Co. were represented by "a highly refractive cut glass chandelier, 24 feet in length, by Chandeliers of Alhambra style in white, ruby and blue glass, by cut glass, Anglo-Venetian Table-glass and by cameo incrustations." The latter were small busts or medallions, in low relief, cast in specially prepared clay, which had been embedded in the sides or bases of glass vessels whilst the glass was still in a plastic condition.

The Whitefriars glass-works, near the Temple, the only one of the ancient glass-houses which has survived on its original site, are first heard of in the *London Gazette* of 1709. This factory has always produced table-glass of fine quality and at the present time (1920), in addition to stained glass and mosaics, turns out large quantities of glass tube of all descriptions, especially for thermometers, and glass for X-ray apparatus. These works are more fully described in another chapter as a typical old-fashioned flint-glass factory.

The chief centre of the green glass bottle trade appears to have been Ratcliff, and the names Glass-house Yard and Glass-house Fields are marked in Strype's map. In Southwark bottles were made at the Bear

Garden works, Bankside, at the glass-house near Old Barge Stairs, nearly opposite to the Temple, and at the "great old glass house" which was close to St Mary Overies' Church, now Southwark Cathedral. In central London there were works at Old Bedlam, on part of the site of Liverpool Street Station, and in Pickax Street, out of Aldersgate Street.

Crown window-glass was made from 1678 to 1691 by John Bowles in the Bear Garden glass-house, Bankside, already referred to, and subsequently by members of the same family in the Cock Hill glass-house, Ratcliff. "Broad window glass was made in 1686 in White's Yard, to the west of Saltpetre Bank, Whitechapel." Window-glass was also made in a neighbouring glass-house in Green Yard. The following names of owners of this factory are given in directories: 1760, Quintin and Windle; 1781, Thomas Quintin and Co.; 1799–1810, Quintin and Son —the London Plate Glass Company; 1815–19 Macnamara and Brett. In 1773 Mr Quintin gave evidence before a Parliamentary Committee on the subject of the English plate-glass trade. In that year the French system of casting plate-glass had been introduced. Previously glass plates for mirrors and windows had been made from thick blown glass cylinders.

In Foxhole (Vauxhall) at a spot still probably commemorated by the name Glass-house Street, the Duke of Buckingham in 1673 established a company of Venetians, under a master-craftsman named Rosetti, to make blown plate-glass. John Evelyn in September 1676, when in Lambeth, saw the Duke of Buckingham's glass-works, where they made "huge vases of mettal as clear ponderous and thick as chrystal, also looking glasses far larger and better than any that come from Venice." The huge "vases" may have been the blown glass cylinders from which the mirror-plates were made. About 1680 John Dawson was apprenticed to these works, and became manager and finally owner. His son Edward was sent to Venice to learn the latest developments of the craft. Edward died in 1755, and he was succeeded by his son John, and until 1780 the business was carried on under the name of Dawson, Bankes and Co. These Vauxhall works may be the same as the Lambeth glass-works owned by Sir Edward Zouch, Kt. In 1612 an absolute licence had been granted to Sir Edward Zouch, Bevis Thelwall and others to make all kinds of glasses with sea-coal. In 1613 Sir G. More and Sir Edmund Bowyer visited Sir E. Zouch's factory in Lambeth and reported to the king that "the glass made was generally clear and good."

Early in the eighteenth century the Bear Garden glass-house of Bankside, previously mentioned in connection with bottles and crown glass, temporarily eclipsed the Vauxhall works in the production of blown plate-glass for mirrors, "free from bladders veins and foulness," but in 1726 Vauxhall resumed its supremacy.

In 1641 there was a glass-house in Greenwich owned by Jeremy Bago and Francis Bristow. The former married Suzanna Henzey, a member of the great glass-making family. Evelyn states that in June 1673 he "went with friends to the formal and formidable camp on Blackheath and thence to the Italian glass-house at Greenwich, where glass was blown of finer mettal than that of Murano." It is in this glass-house that Mr Hartshorne claims that the famous "Royal Oak" goblet was made.

In the Report of the Excise Inquiry of 1835 the names of the owners of only three London glass-houses are recorded: Apsley Pellatt of the Falcon Works, Holland Street, William Holmes of Whitefriars, and William Christie of Stangate. They were all flint glass-houses. The Stangate works, which were on the river-side near Lambeth Palace Road, were closed in 1851. Of the many old glass-houses recalled by Mr Buckley, the only survivor is that of Whitefriars, which is shortly to be moved to the country. Since 1835 several glass-houses, some large, some small, have arisen. The Albion Cast-Plate Glass Factory, started in Southwark, did not survive for many years. Vast bottle works have recently been established in Canning Town, and Edison and Swan have large works for making electric light bulbs and tube at Ponders End. There are less important factories in Clapton Park, Lower Edmonton, Upper Kennington Lane, and Vauxhall. The last not far removed from the site of the ancient glass-house of the Duke of Buckingham.

CHAPTER VII

PROVINCIAL GLASS-HOUSES

THE NEWCASTLE DISTRICT

COAL, fire-clay and water-carriage were the chief attractions of the Newcastle district to glass-workers. It was also famous, according to Dr Christopher Merret, who wrote in 1662, for a silicious material called pyramachia used for the inside lining of furnaces. The glass industry may have existed in the neighbourhood on a small scale before 1615 in which year the proclamation forbidding the use of wood for fuel for glass-furnaces was issued. The proclamation, however, undoubtedly caused rapid and extensive development. In 1619 the registers of the churches of St Nicholas, now the cathedral, and of All Saints, commenced a long record of the well-known names of immigrant glass-men: Isaac Henzey, glass-maker; Jacob Henzey, glass-maker; John Tesswicke, son of Timothy Tesswicke, glass-maker, a Prenchman, and many others. Sir Robert Mansell in 1614 joined Sir Edward Zouch's company which held the monopoly for making all kinds of glasses with sea-coal or pit-coal, and by 1617 had started glass-works in Newcastle. In the register of 1618 of All Saints' Church is recorded the death of Edward Henzey servant of Sir Robert "Mansfield" (Mansell). From 1618 until Mansell's death in 1653 all the Newcastle glass-houses must have been worked under his direct control or under his licence. The window-glass was packed in cases and sent to London in the coal-ships, which brought back barillia and other glass-making materials. In London the glass was sold by Mansell's agents. In later years John Tyzack's warehouse for Newcastle glass near the Old Swan Stairs was well known. In 1691 Newcastle cut window-glass was sold at 13*s.* per 100 feet.

In 1637–8 in consideration of surrendering a former lease a new lease was granted by the Newcastle Common Council to Sir R. Mansell of "certain grounds, being the greatest part of the East-ballast-Shoares including the glass-house on the Usebourne." The books of the Common

Council contain records of leases of glass-houses or sites for glass-houses:

1646. Lease to Edmund Harris, of London, of parcel of ground at St Laurence Shore to erect certain glass-works.

1656. Lease to John Hatteril and R. Tainton, citizens and glaziers of London, of the old glass-houses, to run with that of the new glass-houses.

1658. Lease to Tainton and Pollicot, glass-men, from London, of the old glass-house.

1678. Lease to Tainton and Oliver of the Western glass-houses.

1679. Lease to Jacob Hensey, William Tizacke and Daniel Tyttery of the Western Glass-house: glass to be supplied to inhabitants at fixed rates. (Tainton and Oliver had apparently not been successful.)

1684. New lease to John Hensell, Peregrine Tizack and others of the Eastern glass-houses for twenty-one years.

During the siege of Newcastle by the Scots in 1644 all glass-working was suspended.

Houghton's list of glass-houses in England in 1696 gives for the Newcastle district, six window (broad-glass) houses, four bottle-houses and one for flint, green and ordinary glass. The Newcastle Common Council's books refer to the following glass-houses: 1692, glass-house at Howdon-pans; 1694, glass-house at Bill-key; 1710, glass-house at Close-gate; 1737, broad-glass-house at Howdon; the Close-gate bottle-house, Western bottle-house, St Laurence bottle-house, Bill-key bottle-house, and flint-glass-house at Close-gate. In 1710 permission was given by the Common Council to the glass-makers to erect at their own charge a gallery at the west end of St Anne's Chapel for their own use.

Between 1695 and 1699 a number of petitions by the glass-makers of Newcastle were presented to Parliament, first for the reduction and latterly for the total removal of the glass-tax, and in 1696 the Henzells, Tyzacks and other glass-makers petitioned for the withdrawal of the duty of 5*s*. per chaldron on water-borne coal. In 1698, owing to the burden of taxation, all the glass-furnaces were shut down. Early in the eighteenth century the Newcastle window-glass does not seem to have been of first-rate quality. It is stated in Neves' *Builders' Dictionary* of 1703 that although the Newcastle window-glass was mostly used it was subject "to specks, streaks and blemishes, and was often warped and of ash-colour." A lease of 1737 refers to the building of two glass-houses on the south bank of the Tyne. In 1740 an advertisement states that Cookson and Jeffreys, from their new glass-house at South Shields, were sending the best crown-glass to be sold at their warehouses, the Old

Swan, London Bridge. In 1772 there were sixteen important glass-factories in the Newcastle district, namely five for bottles, five for broad or common glass, three for crown-glass, two for flint and one for plate-glass, probably blown plate. Newcastle directories from 1782 to 1811 have the following entries:

Date	Name	Manufacture	Locality
1782–1801	Airey Cookson and Co.	flint-glass	The Close
1787	Northumberland Glass Co.	,,	Lemington
	W. Henzell and Co.	bottles	East Ballast Hills; Low Glass-house; St Peter's Quay
	W. Elliot	bottles	Mushroom glass-works
1795	J. Cookson	crown-glass and bottles	The Close
1795	Sir M. W. Ridley and Hewitson	crown- and broad-glass	North Shore
1811	Atkinson Wailes and Co.	flint-glass	Gateshead
	Northumberland Glass Co.	,,	The Close
	Cookson and Cuthberts	crown-glass	South Shields
	Northumberland Glass Co.	,,	Lemington
	Sir M. W. Ridley and Co.	,,	North Shore
	Shorter and Co.	,,	South Shore
	Cookson and Cuthberts	bottles	South Shields
	Isaac Cookson	,,	The Close
	Cookson and Co.	,,	The Quay
	Henzel and Co.	,,	North Shore

Although in 1772 a plate-glass (blown glass) factory was at work, no mention of plate-glass is made in the directories from 1782 to 1811. It is interesting to follow the successive changes in the method of making ordinary window-glass. In 1696 broad-glass only was made: in 1772 five factories made broad or common window-glass, and three crown-glass; in 1811 crown-glass only was made; in 1833 crown-glass was made in all window-glass-factories except one in which broad-glass was made for part of the year only. In 1851 the manufacture of crown-glass had practically ceased, and sheet-glass, the improved "broad" glass, was universally used for domestic glazing. The Report of the Commissioners of Excise, published in 1835, gives some information about the condition of the glass industry of the Newcastle district in the early part of the nineteenth century. Ten out of the thirty-eight glass-houses at work in 1833 were owned by members of the Cookson family. The name first appears in connection with glass-making about 1730. In 1746 the firm was Cookson, Jeffreys and Dixon; in 1776, John Cookson and Dixon;

in 1795 J. Cookson, and in 1811 there were four firms in which the name was included. The Cooksons had made blown plate-glass from 1770, the dimensions of some of the plates reaching thirty square feet, but were forced by French competition to almost entirely give up the manufacture. In 1813 they started making "cast plate" in competition with the British Plate Glass Company.

Isaac Cookson gave evidence before the Excise Commissioners and stated that his firm was casting plates measuring eighty square feet. The glass mixture was melted in large pots, and ladled into smaller pots, "cuvettes," for pouring on the casting-table. In 1831 Cookson and Co. of South Shields commenced the manufacture of Fresnel's dioptric apparatus for lighthouses, but, after fitting thirteen lights, were compelled by Excise restrictions to abandon the enterprise. Isaac Cookson, William Cuthbert, John and Thomas Ridley, W. L. Jobbing, R. Todd, and John Coulthard appeared at the Excise Enquiry for the bottle-makers. Seventeen bottle factories were at work. The materials employed were sand, soap-makers' waste, lime, common clay and ground bricks. An Excise regulation forbade the use of crown-glass refuse, although the quality of bottle glass was greatly improved by mixing it with the other ingredients. Isaac Cookson also represented the crown-glass makers and stated that thirteen crown-glass-houses were at work. William Booth, Richard Shortridge and Joseph Price gave evidence on the subject of flint-glass. Only five flint-glass-houses were at work. The Birmingham district turned out more flint-glass than Newcastle. The materials used were pearl ashes, litharge or red-lead, Lynn or Alum Bay sand or "Yorkshire stones burnt and pulverised." It took thirty-six hours to prepare the metal for working. It is doubtful whether the Newcastle district was ever remarkable for fine flint-glass and table-ware. It is true that Mr Hartshorne has "provisionally" suggested that the greater number of the famous rose-engraved "Jacobite" glasses and the generality of the "Fiat" glasses were made and engraved in the district, because the manufacture of such "semi-seditious" or "openly contumacious" objects must have been removed from the immediate scrutiny of the Government. He admits, however, that there is no proof, and it is strange that no tradition has survived of the manufacture of objects of considerable beauty and involving advanced technique.

Before 1833 the making of "pressed" or "intagliated" table-ware

had been introduced from America. In later years Sowerby's Ellison glass-works became famous for pressed glass. The designs were simple and well-adapted for mechanical reproduction. An opaque glass, in various delicate tints, was used with success. The following names must be added to the list of glass-makers at work in 1833: Charles Attwood had one house and Addison Fenwick and Co. two houses at Southwick; W. Featherstonhaugh had one glass-house at Ayres Quay and two at Deptford, Sunderland; John Hubbard, two glass-houses at Deptford; George Stevenson, one at Carr Hill; Joseph Lamb and Co., three houses at Lemington; and George Sowerby, one glass-house at Gateshead.

The Newcastle district has failed to retain the leading position in the glass industry which it held at the close of the eighteenth century and during the early part of the nineteenth. Many branches have died out, and little glass is now made within the city. There are still, however, important glass-factories in Gateshead, Sunderland, Hartlepool and Lemington.

BRISTOL DISTRICT

In the seventeenth century Bristol was the chief provincial town, and its port was larger than any English port except that of London. The facilities for importing raw materials and for exporting finished goods, together with the accessibility of coal, made it an admirable centre for the manufacture of glass. There was, too, a large demand for all kinds of glass, but especially for bottles for Bath and Bristol waters, beer, cider and perry, from the whole of the west of England as well as from Ireland and the Plantations. Houghton, writing in 1696, speaks of nine glass-houses in and about Bristol, five for bottles, one for both bottles and window-glass, and three for flint and ordinary glass; of these, however, Hooper's bottle-factory at Temple Gate is the only one of which any definite record survives. Mr Francis Buckley's researches among ancient newspapers, newsleaves, lists of freeholders and burgesses and directories have given the following results: in 1712 crown-glass was being made by Richard Warren and Co. in Thomas Street; in 1722 thirty-six parliamentary voters are described as glass-makers, and the number rose to fifty-three in 1734; in 1736 Sir Abraham Elton had a large glass-house in St Philip's; in 1738, when Prince Frederick and Princess Augusta visited Bristol, the procession of city companies was

headed by the company of glass-men, carrying glass swords, sceptres and trumpets. In Evans' *History of Bristol* it is stated that in 1761 fifteen glass-houses were at work. Hugh Owen, F.S.A. in *Two Centuries of Ceramic Art in Bristol*, quoting from a ledger kept by Michael Edkins, the painter in enamels, gives the following list of the firms who supplied him with glasses for decoration between 1762 and 1787:

Little and Longman of Redcliff Back, 1762–7; Longman and Vigor, 1767–87; Vigor and Stevens of Thomas Street, 1775–87; and Lazarus Jacobs of Avon Street, 1785–87.

The directories of 1794 and 1801 have yielded to Mr Buckley the following results:

1794	1801
Cannington and Co., Temple Street.	
Elton Miles and Co., Cheese Lane.	Elton, Miles and Wilcox.
Henry Payne, St Philip's.	Henry Payne, Broad Quay.
Edward Smart, Cheese Lane.	Edward Smart, Avon Street.
Stevens, Cave and Co., Redcliff Back and Thomas Street.	W. Stevens.
Wadham Ricketts and Co., Without Temple Gate.	Ricketts, Evans and Ricketts.

J. R. Lucas, who previously had a bottle-factory in the city, started works, probably for crown-glass, at Nailsea Heath in 1788.

Matthews, in his *History of Bristol*, says that A. Vigor and Co. were making flint-glass in Redcliff Back in 1794. In the Excise list of 1833 only four firms are named: Henry Ricketts and Co. (two houses); John Nicholas and Co.; Thomas Powell and Co.; and Coathupe and Co. of Nailsea Heath (two houses). The latter was the only firm represented in the Great Exhibition of 1851, and Hugh Owen, writing in 1872, speaks of Powell and Ricketts as the only firm of importance still working in Bristol. The decline of the glass industry in Bristol was due to taxation, to competition and to the increasing difficulty of obtaining an adequate and cheap coal supply. That glass-houses were a feature in the distant view of Bristol as late as 1820 is proved by Miss Edgeworth's description of a drive from Clifton to Bristol in *Harry and Lucy*. She refers to "a number of very high black-looking buildings in the shape of huge cones from which still darker coloured smoke in thick volumes is continually issuing." In Bristol Harry and Lucy were introduced with full explanations to the manufacture both of crown-glass and wine glasses.

There can be no question as to the importance of Bristol as a glass-manufacturing centre from the end of the seventeenth century to the early years of the nineteenth, but the records are so few and so confused that it is only possible in a few cases to assign definite products to definite firms.

During the first part of the period the manufacture of bottles predominated, but by 1833 the value of the output of crown-glass was three times as great as the combined value of the output of all other kinds of glass. In the glass-history of Bristol the following names have been connected with different varieties of glass:

Bottles were made by Hooper Bros.: J. R. Lucas: Wadham and Ricketts: Henry Ricketts and Co.: Cookson and Powell: and Powell and Ricketts.

Crown glass was made by Richard Warren and Co.: Vigor and Co., of St Thomas' Street: Stevens Randolph and Co.: J. R. Lucas: Lucas, Chance, Homer, Coathupe and Hartley: Coathupes and Co.: and by Chance and Co.

Flint glass by J. and G. Taylor: Cannington and Co.: A. Vigor and Co.: Wadham and Co.: Henry Ricketts and Co.: and by Stevens Randolph and Co.

In addition to flint and coloured glass and enamels *the special milk-white Bristol glass* was made by Little and Longman: Longman and Vigor: Vigor and Stevens: Lazarus Jacobs and Isaac Jacobs his successor. The latter was appointed glass manufacturer to George III. In the Bristol Art Gallery is a blue glass dessert plate, signed in gold on the back, I. Jacobs, Bristol.

It is possible that some at least of the beautiful wine-glasses with enamel twists in the stems, which are to be found in every collection of old English glasses, may have come from Bristol.

Flint-glass of fine quality was produced in Bristol, and Henry Ricketts and Co. were famous for cut-glass. The patterns were not specially characteristic, and closely resembled the contemporary products of London, Stourbridge and Waterford.

The firm of Powell and Ricketts of the Phoenix Glass-works has a long history and underwent many changes and amalgamations. The original firm, at the end of the seventeenth century, may have been Hooper Bros. of the Bottle works at Temple Gate. In 1785 the firm was J. and G. Taylor, flint-glass makers, who were succeeded in 1789 by Wadham and Ricketts, who made flint-glass, coloured glass and bottles, in 1794 by Ricketts, Evans and Ricketts, in 1797 by Ricketts, Evans and Phoenix Glass-works, in 1814 by Henry Ricketts and Co., and in 1853 by Powell and Ricketts. The last change arose from an amalgamation with Powell Bros. and Co., a firm which, starting in 1786 as Lawson,

Fry, Frampton and Co., Glass bottle-makers, in 1812 became Joseph and Septimus Cookson, in 1824 Cookson and Powell, and in 1831 Powell Bros. and Co.

The glass which is specially characteristic, and of which Bristol has cause to be proud, is the milk-white translucent material introduced in imitation of soft-paste porcelain. Specimens of this glass decorated with enamel painting by Michael Edkins are highly prized.

Professor Church's analysis of this glass, quoted by Hugh Owen, is as follows: Silica, 47·75; potash, 6·39; soda, 0·82; oxide of lead, 43·71; oxide of tin, 0·86; alumina, 0·33; lime, 0·14. The density of the glass is 3·58. It was a difficult glass to work, requiring great skill on the part of the glass-blower, and is extremely fragile. Moulds were successfully used, and small decanters and other vessels, thin in substance, light in weight and graceful in form were blown. Two processes of painted decoration were employed, one with oil colours, the other with permanent kiln-fired enamels.

The great Nailsea works were famous for the fine quality of their crown window-glass, but are unworthily commemorated in museums and private collections by the rude vases, flasks, jugs, candlesticks and rolling-pins originally made by the glass-blowers in their spare time. They are colourless or coloured, and many are marked, spotted, streaked or roughly threaded with opaque white enamel or crude-coloured glasses. Similar objects known colloquially as "friggers" may be seen as chimney-piece ornaments in glass-blowers' homes in every glass-making district. In the Bristol district these by-products were exploited by dealers and became for a time staple products. They were widely distributed, and copies are still made in many districts and sold as antiques. Even the originals, with very few exceptions, are entirely devoid of artistic, technical or historic interest.

STOURBRIDGE AND BIRMINGHAM DISTRICTS

In the history of glass-making Stourbridge claims precedence of Birmingham by about one hundred and seventy years. Quite early in the seventeenth century the Lorraine glass-makers made their way from the Forest of Dean to Stourbridge. The reasons for the selection of this

district are given in Professor Plots' *Natural History of Staffordshire* published in 1687:

> The clay which surpasses all others in this county is that at Amblecote, on the bank of the Stour, in the parish of Old Swynford, yet in Staffordshire. It is of a dark bluish colour, whereof they make the best glass-pots in England and is so necessary to be had that it is sent as far as London. The goodness of which clay and the cheapness of coal hereabout no doubt have drawn the glass-houses both for vessels and for broad-glass into these parts, there being divers set up at Amblecote, Old Swynford, Holloway End and Coboyrn Brook.

The pot clay underlies the coal in the mines of the Stour valley. The first known concession for digging clay for glass pots is dated 1566. Stourbridge gives its name to the glass-making district, but nearly all the glass-houses have been beyond the limits of the town.

In 1612 glass-makers settled at Lye. Hungary Hill is said to have derived its name from the foreign immigrants, but Duignan, an authority on Worcestershire place-names, states that the name is Anglo-Saxon, meaning a "hanging wood."

In the church register of Kingswinford of 1612 is recorded the baptism of John son of Paul and Bridget Tyzack. The Tyzacks were closely connected with the great glass-making family of Hennezel and bore the same arms (gules 3 acorns or).

In 1615 Paul son of Jacob Henzie and Zacharias son of Fowler Henzie were baptised in Oldswinford Church, and in 1621 the death is recorded of Edward Henzey of Amblecote, broad-glass-maker. Henzie, Henzey and, possibly, Ensell are a few of the mutilated forms of the original Hennezel. The parish registers of Oldswinford have records of the names of Henzey and Tyzack from 1615 and of Tyttery, another glass-making family, from 1622. The churchwardens' book records the gift on 14 April 1691 by Paul Henzey, senior, of Amblecote, of a large silver bowl "to be and to remain for the use and behoofe of the parishioners of Oldswinford and Stourbridge at the Sacrament for ever." In addition to the Henzey arms the bowl was engraved with the crest, a firebolt and fireball, and the motto, "Seigneur je te prie garde ma vie." Broad-glass making seems to have been the staple industry of the foreigners.

In 1664 Joshua Henzey, probably working under licence from Sir Robert Mansell, owned three glass-houses in Kingswinford and Oldswinford, known by the names "Coleman's Glass-house," "Hood glass-

house" and "glass-house in Bottell." Joshua, who died in 1709, had four sons and ten daughters. By marriage the family of Henzey became connected with the families of Bate, Brettell, Croker, Dixon, Jeston and Pidcock. Robert Foley, coalowner and ironmaster, appears to have been taken into partnership by Joshua Henzey, the younger, broad-glass maker of Amblecote, who died without issue in 1738 and was succeeded by his nephew John Pidcock.

According to Houghton's list of glass-houses in 1696 there were in the Stourbridge district seven for making window-glass, five for making bottles and five for making flint, green and ordinary glass. Between 1695 and 1699 the district made four petitions against the glass-tax.

In January 1712 the Henzeys of Stourbridge advertised in the *London Gazette* the sale of broad-glass at 22*s*. per case. In 1717 Paul, John and Joseph Henzey were making broad-glass in a factory near Brettle Lane. Between 1700 and 1800 the following names of owners or part-owners of glass-houses are recorded in addition to those of Henzey and Tyzack: John Bague, Elisha Batchelour, Edward Baughton, T. Bradley, John Bradley, Thomas Cardo, Ensell, John Grazebrook, Michael Grazebrook, Holt, John Jeston and Thomas Rogers. The latter, who married Anne Tyttery, was a maker of white glass and bottles and a glass-merchant. His business continued through four generations. Bague and Jeston were also bottle-makers.

That Stourbridge was recognised as early as 1751 as an important centre of the glass industry is proved by Dr Richard Pococke's reference to it in his *Travels through England*:

> June 1751, came to Sturbridge famous for its glass manufacture...especially for its coloured glass with which they make painted windows: it is here coloured in the liquid, of all the capital colours in their several shades and, if I mistake not, is a secret which they have here.

In 1785 Mr Hill, a glass-manufacturer of Stourbridge, took glass-workers to Waterford. Stourbridge may therefore claim parentage of the famous Waterford glass.

The Excise Report of 1835 gives the following list of manufacturers in the Stourbridge district who paid the tax in 1833:

> Michael Grazebrook, Audnam: W. S. Wheely, Brettle Lane: Thomas Hill, Coalburn Brook: Thomas Davis and Co., Dickson's Green: Joseph Guest and Co., Thomas Badger and Co., and Thomas Hawkes, Dudley: Joseph Stevens and Co., Holly-Hall: Thomas

Littlewood, Holton End: Joseph Silvers and Co., and Edward Westwood and Co., Moore Lane: John H. Pidcock and Co., Platts: William Chance, Spon Lane: Philip Rufford, Stourbridge Heath: R. B. Usell, Sarah Ensell and Thomas Webb and Co., Wordsley.

The Brierley Hill Glass-Works, now owned by Stevens and Williams, were founded in 1779 by Richard Honeybourne, who claimed connection by marriage with Joshua Henzey. The firm has been successively known as Silvers, Mills and Stevens, William Stevens and Samuel Cox Williams, and Stevens and Williams. They have specialised in glass-cutting and intaglio work. The Wordsley Flint-Glass Works of the present firm of Henry G. Richardson and Sons were owned in 1825 by Wainwright Bros. In 1829 the Wainwrights were joined by Benjamin Richardson and Thomas Webb, afterwards of "Platts" and Dennis Park, and the firm became Webb and Richardson. Richardson who claimed the development of etching on table-glass and the introduction of topaz and chrysolite glasses, was for a time associated with Philip Pargeter and John Northwood. Pargeter, when he took the Red House Glass-Works, co-operated with Northwood in the reproduction, in material and technique, of the famous Portland vase. Thomas Webb, the founder of the Dennis Glass-Works, migrated from Wordsley to the White House, from the White House to Platts, where he took three sons into partnership, and in 1856 from Platts to Dennis Park, Amblecote. Wilkes Webb encouraged George Woodall in cameo decoration and sent to the Exhibition of 1862 a jug engraved by Northwood with a copy of part of the Parthenon frieze, now in the Birmingham Art Gallery. In the 1851 Exhibition Chance Brothers and Co., of Spon Lane, Richardson of Wordsley, Davis Greathead and Green of Stourbridge and Thomas Webb of Platts were represented. In the 1862 Exhibition the only representatives of the district were Chance Brothers of Spon Lane and W. J. Hodgetts of Wordsley.

Chapter fifteen contains a record of the efforts made by the Stourbridge and Birmingham districts to meet the demands for glass in every form created by the war, 1914–18. Amongst the members of the National Glass Research Association, 1919–20, are representatives of Chance Brothers, Fleming Joseph and Co., Hands and Son, Icknield Glass-Works Company, Lane and Sons, Samuel Pearson and Co., Plowden and Thompson, Richardson and Sons, Stevens and Williams, Stuart and Sons, Tomey and Co., Walsh and Walsh, Thomas Webb and Corbett, and Thomas Webb and Sons.

BIRMINGHAM

In the report on the Industrial History of Birmingham, prepared by S. Timmins for the Meeting of the British Association in 1866, it is stated that no glass was made in Birmingham before 1785. No reason is given for fixing this date. A Birmingham directory of 1781 contains the name of no glass-maker, but of a glass-cutter named Isaac Hawkes, and it is known that about that date Hawkes put up a glass-furnace behind his shop in Edgbaston Street. Hawkes' son built the Park Glass-Works in Birmingham Heath, which in later years passed into the hands of Lloyd and Summerfield. In 1798 Johnston and Shakespear owned a glass-house in Walmer Lane, and W. Shakespear founded the Soho and Vesta Glass-Works in the Lodge Road, which were subsequently taken by Walsh and Walsh.

A directory of 1822 gives the following list of the owners of glass-houses: Shakespear and Fletcher; Bacchus and Green; Biddle and Lloyd; Harris Gammon and Co.; and Johnson Berry and Co. In the Excise List of 1833 the names appear as: Hannah Shakespear and Co.; G. Bacchus and Co.; John Biddle; W. Gammon and Co.; and Rice Harris and Co. The name Osler does not appear in either list. Thomas Osler who had been educated for a medical career took up the manufacture of glass toys and glass pendants and spangles for chandeliers in premises in Great Charles Street in 1807. One of the outstanding features of the 1851 Exhibition was a cut-glass fountain, twenty-seven feet in height, exhibited by F. Osler and Co. of Broad Street and Freeth Street.

The other Birmingham exhibitors were George Bacchus and Sons who showed cut, engraved and coloured table-glass, and glass decorated with enamel and gilding: Lloyd and Summerfield, who showed cut and engraved table-glass, "Medallion busts" and coloured glasses for church windows; C. Pache, who showed artificial glass eyes; and Harris Rice and Son, who showed "pressed" table-glass. In the 1862 Exhibition Osler and Co. and Lloyd and Summerfield were the only representatives of the Birmingham glass-makers. Lloyd and Summerfield were amongst the first to make trial of a Siemens regenerative furnace.

THE SPON LANE WORKS

WINDOW-GLASS: "CROWN" AND "SHEET"

In the fourteenth century John Alemayne, of the Chiddingfold glass-works in Surrey, was making and supplying colourless glass for glazing the windows in St George's Chapel, Windsor, and St Stephen's Chapel, Westminster. It is probable that the manufacture of window-glass was continued on a small scale, and in 1567 Jean Carré, a native of Antwerp residing in London, applied for a monopoly-licence for making window-glass, stating that he had already erected a glass-house in Sussex and had brought skilled workmen from abroad to make "Lorraine" and "Normandy" glass. The most important of the foreign craftsmen were Thomas and Balthazar de Hennezel, whose descendants, Paul, John and Joseph Henzey, were making window-glass in the Stourbridge (Spon Lane) district in the early part of the eighteenth century. "Normandy" glass was made in the form of "crowns," "tables" or "discs": "Lorraine" glass, known as "Broad," "Great" or "Spread" glass, in cylinders, which were slit and unrolled into rectangular sheets. The sheets were irregular in form and substance, seldom exceeded four square feet in area, and had a rough and "cockled" surface. These defects were due to the small dimensions and unevenness of the cylinders, to the method of slitting them, while still hot, with iron shears, and to flattening them on an iron sheet, covered with sand[1]. The "Normandy" glass "crowns" or "tables" had a brilliant surface, but owing to their shape and the central "bullion," the mark of attachment of the glass-blower's working-iron, they could not be economically cut into large rectangular panes, and the panes, owing to a slight curvature, caused some distortion of vision. Houghton's list of glass-factories in England in 1696 contains twenty which are described as making crown-glass, broad-glass and blown plate-glass, but does not specify how many were engaged in making each kind of glass. The "blown-plate" glass, referred to, was "broad" glass, made sufficiently thick to allow both surfaces to be ground and polished, the plates being used chiefly for mirrors. English glass-makers for many years mainly devoted their attention to the improvement of the manufacture of crown-

[1] The process of making sheet- or broad-glass, described by Theophilus, had been abandoned. The new process was more rapid and probably produced larger sheets but the sheets would not be so clear or so flat as those made by the older method.

glass, whereas in France and Germany the manufacture of crown-glass was gradually discarded and new and greatly improved processes were introduced in the manufacture of "broad" glass, which in its improved form became known as "German" sheet or "sheet" glass. In the Report of the Excise Inquiry, published in 1835, it appears that out of thirty English window-glass manufactories, twenty-eight made crown-glass, and in the year 1833 produced 103·900 cwt., whereas two made "broad" glass and produced only 5·300 cwt. At that time the important window-glass firms were John Cookson and Co. and Thomas Ridley and Co. of Newcastle, Coathupe and Co., who had succeeded Lucas, Horner and Chance, at Nailsea, and Chance and Hartley of Spon Lane, near Birmingham. Of these the Spon Lane works were admittedly the largest and paid in duty on crown-glass in one year a sum amounting to £54,000. In the inquiry, evidence was received from competent experts as to the comparative merits of crown-glass and broad-glass. Broad-glass, according to the representative of Cookson and Co., "is not an article that will sell in this country, it is what we call 'cockled' and like horn," whereas Lucas Chance said "Broad or sheet glass has superseded all other kinds of window glass on the continent and its use is rapidly extending in this country." Cookson's representative referred to "broad" glass as made by ancient and obsolete methods, but Chance to the continental sheet-glass, the manufacture of which he had recently introduced at the Spon Lane works.

Robert Lucas Chance, known as Lucas Chance, had learnt glass-making under his father and uncles at the crown glass-works of Nailsea Heath, and in 1824 had bought the works of the British Crown Glass Company at Spon Lane, which had been founded in 1815. In 1831 the members of the Spon Lane firm were Lucas and William Chance and John Hartley, who had worked with Lucas at Nailsea. On the death of John Hartley in 1833, his sons John and James became partners, and when in 1837 the Hartleys started their own works in Sunderland the Spon Lane firm became Chance Bros. and Co. As early as 1832 Lucas Chance, with the aid of Georges Bontemps, of Choisy le Roi (author of *Le Guide du Verrier*), and with foreign workmen, had commenced making "broad" or sheet-glass by the methods adopted abroad. The cylinders were blown larger than the old broad-glass cylinders, were allowed to become cold before being slit, were slit cleanly with a diamond, instead of being hacked

with iron shears, and were re-heated in a specially constructed kiln, and flattened on a bed or "lagre" of smooth glass, instead of on an iron plate covered with sand. The new processes yielded clear rectangular sheets, ranging in area from six to ten feet, and it was not many years before the manufacture of sheet-glass had practically superseded that of crown-glass at Spon Lane. The buildings of the Great Exhibition of 1851 were glazed with Chances' sheet-glass, the sheets measuring 49 inches by 30 inches. Subsequently, with mechanical aids to blowing, the size of cylinders was greatly increased, and now by the use of American automatic machinery the length of the cylinder or of the sheet, according to the process adopted, can be almost indefinitely extended.

Other manufacturers had followed the lead which Lucas Chance had given in 1832 and the English sheet-glass industry flourished until the removal of the import duty permitted the introduction of vast quantities of foreign glass. Foreign competition caused the extinction of some works and the reduction of output in others. Chance Bros. continued the manufacture of sheet-glass, but their output has been greatly exceeded by that of Pilkington Bros. of St Helens, who had started the manufacture in 1841. To the Pilkingtons' initiative many developments are due, but the most important was the adoption of tank furnaces for making sheet-glass.

"*Patent plate-glass*" is sheet-glass with both surfaces ground and polished. It possesses the brilliance and transparency of cast plate-glass, similarly treated. For centuries, before the excise period, thick mirror plates, ground and polished, had been made from "broad" glass, blown specially thick, but the grinding and polishing machinery used for thick glass was not applicable to thin sheet-glass, the thickness of which was limited by an excise regulation to one-ninth of an inch. The problem of adapting machinery for treating sheet-glass was taken in hand by James Timmins Chance, afterwards Sir J. T. Chance, who in 1839, after a distinguished career at Cambridge, joined the Spon Lane firm. The main difficulty was to secure the complete adherence of a thin sheet of glass, of uneven surface, to the bed which supports it whilst it is being ground and polished. The difficulty was surmounted by covering the bed with moistened leather and by applying atmospheric pressure. The "patent plate-glass" perfected by J. T. Chance in 1840 was specially suitable, owing to its lightness, for glazing pictures, for small mirrors and for

carriage windows. An extensive demand for it was created by the introduction of photography, but its manufacture in England has now practically ceased.

"*Rolled plate*" or "*Rolled cathedral*" *glass* was invented in 1847 by James Hartley of Sunderland and a licence for its manufacture was granted to Chance Bros. The process resembles that of casting plate-glass, but the molten glass, colourless or tinted, is ladled from the melting pot on to the casting table, instead of being poured, and is rolled out into a large, thin sheet, with a bright but ruffled surface. The sheets are light in weight and cheap in price and are suitable for every kind of glazing requiring translucency rather than transparency.

"*Double-rolled*" *glass* is similar in character to "rolled cathedral," but, instead of being rolled on a table, the molten glass passes between rollers. Although Chance Bros. did not invent double-rolled glass, they improved so greatly on the original machinery that an unworkable process was rendered workable. In 1890 they patented the addition of a second pair of rollers for impressing patterns on the sheets. The double-roll machinery has also been adapted for making wired or "armoured" glass.

The manufacture of *coloured sheet-glass* for church windows was commenced in 1835; in 1843 a stained or painted glass department was started, and painted windows were exhibited in the Exhibitions of 1851 and 1862.

Glass Shades. From early times shades, of the nature of clock shades, round, oval or rectangular, in section, and sometimes of great size, have been made by Chance Brothers.

Glass for Lighthouses. In 1845 J. T. Chance was approached by Sir David Brewster on the subject of undertaking the manufacture of dioptric apparatus for the English and Irish lighthouses. The dioptric system of lighting, which consists in surrounding the source of light with a complex structure of glass lenses and prisms in order to concentrate and direct the beams, is due to the French mathematician, Augustin Fresnel, who died in 1827. Four years after his death Isaac Cookson and Co., plate-glass manufacturers of South Shields, in spite of countless obstacles, imposed by excise regulations, attempted the manufacture, and although their glass-work hardly reached the mathematical accuracy of finish which Fresnel had demanded, succeeded in supplying refracting apparatus to thirteen lighthouses. The South Shields factory was taken

over in 1845 by R. Swinburne and Co., and the lighthouse work, being found to be quite unremunerative, was abandoned. In 1848, owing to political troubles in France, Georges Bontemps undertook the temporary superintendence of certain departments of the Spon Lane works, and brought with him an engineer, Tabouret, who had worked with Fresnel. J. T. Chance was thus enabled with the co-operation of Bontemps and Tabouret to take up the enterprise, and from that time the manufacture of lighthouse glass became and has remained, so far as Great Britain is concerned, a monopoly of Chance Bros. and Co. A large light of Tabouret's construction was shown in the Great Exhibition of 1851. It was a combination of Fresnel's revolving drum of eight annular refracting lenses with fixed reflecting (catadioptric) zones, above and below. The jury pronounced the colour of the glass to be inferior to that of a similar French apparatus, but admitted that in other respects the English apparatus was equal or even superior. From 1854, however, the reports of Faraday, scientific adviser to the Trinity House, and of other experts were uniformly favourable. When in 1858 a Royal Commission was appointed to inquire into the condition of the lights, buoys and beacons of the United Kingdom, the co-operation was sought of J. T. Chance, who on account of his energy and mathematical attainments was well equipped for the task. The lights of England and Ireland were found to be far from efficient, and much inferior to those of Scotland, which were under the able supervision of the Stevensons. To the improvement and perfecting of the English and Irish lights James Chance devoted twelve of the best years of his life. The lights of larger size constructed by him for all parts of the world, mostly from his own designs, exceeded 180 in number. At the Paris Exhibition of 1867, when English and French apparatus were subjected to photometric tests, the former showed a superiority in efficiency of from $5\frac{1}{2}$ to 8 per cent.

On J. T. Chance's retirement in 1872 from the management of the lighthouse works, he was succeeded by Dr John Hopkinson, whose principal achievement was the invention of the "group flashing" system, which has tended to remove the difficulty of distinguishing between one coast-light and another. In 1895 direction of the department was taken over by H. J. S. Stobart.

Since 1855 Spon Lane has sent out well over one thousand sea-lights, small and large, culminating in giants such as the hyper-radial

light of 1,100,000 candle-power at Cape Race, Newfoundland. The glass alone of this light weighs three tons, and the whole apparatus, weighing over seven tons, revolves easily on its bath of mercury once every half minute. Among the products of the Spon Lane lighthouse works are mirrors and divergers for searchlights, the demand for which during the war taxed the capacity of the department to the utmost.

OPTICAL GLASS

Optical glass, in the glass trade, is understood to be glass which has been rendered homogeneous and fit for use in optical instruments by prolonged stirring, while in a liquid condition. The effect of stirring on the homogeneity of glass was discovered by Louis Guinand at the end of the eighteenth century. When John Dollond, son of a Huguenot weaver in Spitalfields, succeeded in 1757 in obtaining refraction without colour by the combination of two glasses of different refractive powers, he had to depend for the twin-components of his achromatic lenses on finding exceptionally homogeneous fragments of crown and flint-glass. In 1824 the Royal Astronomical Society of London appointed a committee to consider the possibility of making glasses suitable for use in telescopes, and Faraday, who carried out the research work for the committee, confirmed the conclusion previously arrived at by Guinand and by Fraünhofer that homogeneity, an essential quality of optical glass, can only be obtained by the mechanical agitation of the molten metal. An account of Faraday's experiments was published in the *Transactions of the Royal Society* of 1830. Up to that time, owing to the restrictions of the Excise law, no English glass-manufacturer had attempted to make use of Guinand's discovery. John Dollond's grandson and other opticians had still to rely on extra thick ordinary crown-glass from Spon Lane and on thick slabs of ordinary flint-glass from London manufacturers, both made in defiance of the law, and both far from fit for optical work. In Switzerland and France, however, manufacturers had already employed Guinand's method with success. Georges Bontemps, of Choisy le Roi, had the assistance of one of Guinand's sons, and in 1837 proposed to Lucas Chance to co-operate in introducing the process into England. In 1838 Chance took out an English patent, for Guinand's process, and put up a small furnace for making optical glass on an experimental scale. Little progress was made until Bontemps came to England in 1848, when

five simple varieties of optical glass were made, which obtained a ready sale. In the London Exhibition of 1851 Chance Bros. and Co. showed a number of perfectly homogeneous discs, two of which were 29 inches in diameter.

Dollond had succeeded in neutralising the primary spectrum produced when light passes through a refractive medium, but the problem of the secondary spectrum had still to be dealt with, which, for its solution, required the manufacture of new glasses of distinct chemical composition, possessing greater variability in their refractive and dispersive powers. The need for such glasses had been realised as early as 1834 when W. Vernon Harcourt took up the research and tested in his experimental meltings the effects of no less than thirty different oxides, including boric, phosphoric and titanic acids. In 1862 G. G. Stokes co-operated with Harcourt, and at the British Association meeting of 1874 they were able to show a small object-glass, which, although the component glasses were far from perfect, was absolutely achromatic. The research, initiated by Harcourt and Stokes in England, was in 1881 taken up by Abbe and Schott of Jena and was prosecuted with such success that in 1886 the Jena glass-works issued a trade catalogue containing no less than forty-four distinct utilisable optical glasses. The task they had set themselves was to determine the optical properties of glasses of all possible chemical compositions, and in the course of their investigation over one thousand meltings were made. Chance Bros. and Co. waited until 1895 to attempt the manufacture of the new "Jena" glasses, and were not completely successful until 1914.

Then they were rewarded for their perseverance in maintaining in the public interest an unremunerative industry. From the very commencement and nearly until the end of the war the Empire became dependent on them alone for the supply of optical glass for the thousands of field-glasses and other optical instruments required for war service. With the help of the Government Chance Bros. multiplied their furnaces and built and equipped a new and complete laboratory for research. In the first six months of 1914 the output of optical glass was 2600 lbs., whereas the output in the first six months of 1918 was 92,000 lbs.

CHAPTER VIII

COLOURED GLASS

COLOURED glass suggests stained and painted windows, but serves many other purposes. It is used for making and decorating table-ware, for vases, for shades for gas, oil and electric light; for signalling; for shades and light-filters in photography; for imitating gems; for jewellery; for medical tests; for spectacles, and if opaque glass be included, for covering floors, walls and ceilings with mosaic.

The first making of coloured glass was probably accidental. Marion Crawford, in the Venetian story of *Marietta*, quotes the tradition that the discovery of ruby glass was due to the fall of a copper spoon into a crucible of molten glass, previously colourless, and it is possible that such an accident might give rise to slight streaks of ruby.

It is difficult to give even an approximate date for the intentional manufacture of coloured glass in England. Benedict Biscop is said to have imported one or more glass-makers from Gaul, in 675, to glaze the windows of his church at Wearmouth and to teach the art to Englishmen. There is, however, no record of any result, and, if the glass was made, it was probably not intentionally coloured. English glass-makers would most gladly claim for their predecessors the gem-like glass of the twelfth and thirteenth century windows, and parts of windows, which have survived in York Minster, the cathedrals of Canterbury and Lincoln and elsewhere, but there is no proof on which the claim can be based. These windows in technique and in the tints and texture of the glass so closely resemble windows of similar date in the French cathedrals of St Denis and Chartres that they must be attributed to the same source and it is impossible to suggest that the glass in the French cathedrals was made in England. As in the case of Wearmouth Church, glass-workers may have been sent from France to make the glass and paint the windows in England, but it is more probable that the glass was imported.

Britton, in his *History of Exeter Cathedral*, records the import from Rouen of a large quantity of glass for the cathedral between 1303 and 1317. Mr Winston (*Art of Glass Painting*, p. 171) says: "I have been

much struck with the purity and hardness of the Exeter glass," qualities also noticeable in the "early decorated" glass in Westminster Abbey and in the chapel of Merton College, Oxford. The Exchequer Rolls of Edward III, 1352, give the first reliable evidence of glass being made for windows in mediaeval England, but it is doubtful whether the evidence refers to coloured as well as to colourless glass. Edward III had requisitioned glasiers and glass for St Stephen's Chapel[1], Westminster. John Alemayne (de Alemayne), a glass-maker in Chiddingfold, Surrey, supplied several consignments of glass through W. Holmere of Candlewick Street in the city, who acted as agent and carrier. The glass specially sent from Chiddingfold was colourless, but Holmere supplied azure glass from some other source, probably abroad. Coloured glasses were also obtained from other agents; red from Henry Staverne, blue from Leuen Crawe and white and other colours from John Prentis. The same Rolls throw light on other materials, besides glass, used in the manufacture of a painted window. Thus, silver filings were bought, to be oxidised by heat, and used for producing a permanent yellow stain on the surface of the glass; and "geet," a black enamel, was bought at 8*d.* per lb. to be ground to powder and mixed with "arnement" (bought at from 3*d.* to 4*d.* per lb.), to serve as a fusible dark-coloured paint for delineating features and outlines and for shading. Theophilus, writing early in the thirteenth century in the *Schedula Diversarum Artium*, suggests as a form of arnement[2], copper beaten fine and burnt to powder (a mixture of cupric acid and cuprous oxide). The fabric Rolls of Durham Cathedral record the purchase of 100 lbs. of English glass in 1399, but it is not stated whether coloured or colourless or whence obtained. The Rolls of York Minster contain entries of purchases of glass by successive master-glasiers from 1418 to 1536. Robert Yarndon bought white glass from John Glasman of Rugeley, Staffordshire in 1418; Matthew Petty in 1457 bought glass of diverse colours, *vitrum diversi coloris*, from an agent in Hull, Peter Faudkent, and in 1536 William Matthewson, also of Hull, supplied 21 wyspes of Burgundy glass, coloured and white. It appears

[1] In 1800, when the House of Commons was enlarged, some of the glass of St Stephen's Chapel was found *in situ*; there were specimens of amber, two blues, green, pink, ruby and violet.

[2] Eraclius recommended the use of iron forge scales: Guglielmo de Marcillat in the fifteenth century used "Scaglia di rame," copper scales.

that in mediaeval times Burgundy glass, *i.e.* broad- or sheet-glass, plain and coloured, was imported *via* Antwerp and Hull, whilst Normandy crown-glass was exported from Rouen to English ports on the south and west coasts.

In 1447 John Prudde, glasier of Westminster, contracted to glaze all the windows in the "new Chappell in Warwick (Beauchamp Chapel) with glasse beyond the seas and with no glasse of England, and in the finest wise, with the best, cleanest and strongest glasse beyond the seas that may be had in England and of the finest colours of blew, yellow, red, purpure, sanguine and violet." The word "purpure" recalls the curious relation which exists between the tinctures of heraldry and the limited palette of coloured glasses used in early mediaeval windows. It seems possible that the herald's palette may have been derived from that of the master-glasier. It has been suggested that the clause in the contract for the windows in the Beauchamp Chapel, forbidding the use of English glass, and implying that the manufacture, if in existence, was in an unsatisfactory condition, was due to some mistake. But in the licence granted to John Utynam in 1449 by Henry VI, it is definitely stated that the art of making coloured glasses has never been used in England, and it must be remembered that this statement was made by the grantor, not by the grantee. The licence was to enable Utynam,

> born in Flanders but returned to England by the King's command, to settle with his family and become the King's liege, in order to make glass of all colours for the windows of the Chapels of Eton College and of the College of St. Mary and St. Nicholas in Cambridge. Calendar of Patent Rolls: Henry VI, 1446–52.

Whether Utynam settled in England and made coloured glasses for Eton and King's College, Cambridge, is unknown. The few remains of fifteenth century painted glass in King's Chapel appear to have come from some other building.

In the contract of 1526 between Robert Hacomblyn, D.D., provost of King's College, Cambridge, and Galyon Hoone, glasier, "of the paryshe of Seint Mary Magdalen, next St. Mary Overy in Suthwerke," and others, for glazing eighteen windows of the college "with good, clene, sure and perfyte glass and oryent colors, all the seid wyndowes to be bound with double bands of lead for defence of great wyndes and outrageous wetheringes," the word "Normandy" before the word glass has been erased. The erasure may mean either that "Burgundy" or

Flemish glass was to be substituted for "Normandy" glass or that good English coloured glass was at last obtainable. Reference to the "books of rates" which record the duties charged on goods imported from abroad proves that both "Normandy" and "Burgundy" glasses, white and coloured, were imported in considerable quantity, certainly to the end of the seventeenth century. The importation of Flemish glass must have been stimulated by the coming to England of Bernard van Linge, the glass-painter, early in the century; and the gradual replacement of the use of transparent coloured glass by the use of enamel paints would not encourage the development of the home manufacture of coloured glasses. Bernard van Linge's famous east window in Wadham Chapel, Oxford, dated 1622, shows the well-balanced use of coloured glass and coloured enamel, but the windows of Abraham van Linge and of the English glass-painters, who followed him, illustrate the gradual decrease in the use of coloured glass and the increase in the use of enamels. The master-glasier was succeeded by the enamel-painter and the effects of enamel painting can be judged by the works of the Prices of Hatton Garden, of William Peckitt of York (1731–95), of Francis Egginton of Birmingham (1737–1805), of Pearson, who painted the window in Salisbury Cathedral (designed by Mortimer), representing Moses uplifting the brazen serpent, and of Thomas Jervais, who, in 1782, painted the west window of New College Chapel, Oxford, designed by Sir Joshua Reynolds. This window in recent years has been cased with sheet-glass in the hope that the complete destruction of Jervais's enamel paints may be temporarily postponed. The decay of enamel paints has been almost invariably due to the presence of borax in the mixtures. Borax causes an enamel to fuse easily and smoothly, but being readily attacked by moisture gradually dissolves out and the paint disintegrates. From time to time interest has been aroused on the subject of the decay of the actual substance of mediaeval window-glass. *Archaeologia*, 30 November 1872, contains a full and accurate description by James Fowler, F.S.A., of the various forms of decay in ancient glass. It must not be assumed that decay is necessary. Many pieces of ancient Roman glass show no signs of it and a great deal of twelfth and thirteenth century window-glass is perfectly sound or merely superficially roughened and pitted. Some mediaeval glass, however, has become partly or wholly opaque and is so completely disintegrated as to crumble to powder. The most defective glass belongs

to the fourteenth century and the condition of some of the fourteenth century windows in York Minster first drew serious attention to the subject of decay. It is known that a large proportion of the glass used in the Minster is Flemish, and it would be interesting to ascertain whether the Flemish glass is more liable to decay than the Norman. There are many different forms or stages of decay, but all have originated from an excessive proportion of alkali in the glass mixture which has caused the glass to be hygroscopic. Considering the haphazard

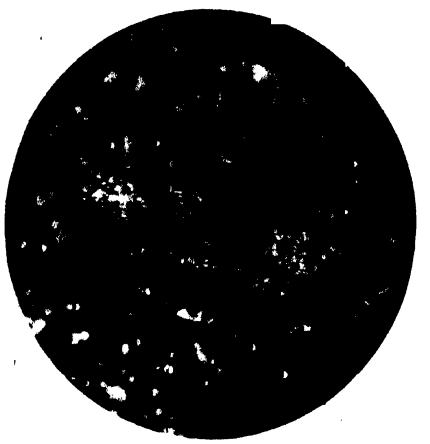


Fig. 88. Micro-photograph of a piece of decayed 14th century glass, dug up on the site of Lesnes Abbey.

way in which alkali was added to the glass mixture by mediaeval glass-makers, it is more remarkable that a large proportion of mediaeval glass has survived than that a small proportion has failed. The micro-photograph (Fig. 88) is taken from a fragment of decayed fourteenth century glass found on the site of Lesnes Abbey. It is nearly opaque and can be readily crumbled to powder. Nuclei will be seen surrounded by concentric rings which have spread and coalesced. The effect curiously resembles the "Liesegang" rings caused by colloidal diffusion. Decay is not unknown in modern glass. A few years ago it was feared that the fourteenth-century windows in the Latin Chapel of Christ Church, Oxford were perishing. After a careful examination it was found that the

genuine fourteenth century glass was perfectly sound, but that some imitation fourteenth century glass used to patch the window early in the last century had perished hopelessly. The writer has examined two specimens of glass certainly less than fifty years old which crumbled to fragments through decay: one was a virulent green glass, coloured with oxide of chromium, in which crystallisation had taken place, the other a pure white potash-lime glass which was highly hygroscopic.

The first definite information about the making of coloured glass in England is to be found in Dr Pococke's *Travels through England*: "1751, 8 June, came to Stourbridge famous for its glass manufacture which is here coloured in the liquid of all the capital colours, in their several shades, and if I mistake not is a secret which they have here." It is, however, doubtful whether any genuine copper-ruby glass was made either in Stourbridge or abroad during the eighteenth century. The art of making it seems to have been temporarily lost, and to take its place recourse was had to the use of a strong orange-coloured silver stain, the effect often being intensified by a wash of red or pink enamel. There is a specification for a patent for making transparent red glass, dated 5 December 1755. The applicant proposes to obtain the colour by melting flint-glass with an equal quantity of "braunstein" and adding twenty grains of dissolved Dutch gold. "Dutch gold" is an alloy of copper with zinc, and "braunstein" is an impure oxide of manganese. The colour, if colour there was, was probably a purple due to manganese, and not ruby. The credit of re-discovering the old method of making copper-ruby glass is attributed to Georges Bontemps, glass-manufacturer, of Choisy-le-Roi, in or about the year 1826. The tradition of making coloured glasses must have lingered in the Stourbridge district, for in the Exhibition of 1851 coloured sheet-glass was exhibited by Chance Brothers of Spon Lane and by Lloyd and Summerfield of Birmingham. The manufacture of coloured sheet-glass by Chance Brothers dates from 1837, when they produced a green pot-metal glass and glasses stained lemon, yellow and red.

In 1848 Georges Bontemps took charge of the coloured glass department at Spon Lane. In 1857 the new copper-ruby sheet-glass was made for the first time. This glass could be re-heated for painted decoration without losing its colour, a defect of the copper-ruby previously made. The list of colours in 1857 included purple, yellow, yellow-green,

signal green, several shades of blue and a flashed opal. Gold-ruby sheet-glass was a later development. Painted glass windows were shown at the Exhibitions of 1851 and 1862. The *Illustrated London News* in June 1851 mentions Messrs Chances' green glasses as "pre-eminent for brightness and transparency." The jurors of the 1862 Exhibition considered Chance Brothers' coloured glass "better than the foreign which has a dead appearance and looks stringy and smeared." In 1867 the painted glass department was given up. In 1873 the manufacture of antique coloured glass was transferred to the Oldbury works. The making, however, of lightly tinted "cathedral," "figured" and "muffled" glasses was continued and developed, as well as of signal green glass and flashed ruby glass for signal lamps. In the late sixties Chance Bros. obtained certain coloured glasses, including gold-ruby, yellow-green and opal, from George Wood of Birmingham, who had been associated with Lloyd and Summerfield for many years. From 1870 to 1873 George Wood worked for Chance Bros. at the Spon Lane works. Alfred Wood, son of George Wood, joined James and William Hartley of the Wear Glass-Works, Sunderland, in 1891. In 1892, when the Wear Glass-Works were closed, James Hartley and Alfred Wood started the manufacture of antique coloured glasses at the Portobello Works, which have won a name for glasses of fine quality.

In London, improvements in the manufacture of coloured glasses for mosaic windows were due to the enthusiasm of an amateur. Charles Winston, barrister and archaeologist, devoted his spare time to the accurate study of ancient painted glass with a view to finding the cause of the failure of modern reproductions, and a sure basis for the revival of the art of glass painting. He applied himself to the examination and comparison of specimens of old glass, to chemical analysis, and to the manufacture on an experimental scale of various colours from recipes preserved in the treatise of Theophilus. His researches convinced him that the beauty of ancient painted glass depended as much at least on the quality of the material as upon the skill of the artist. Writing from the Temple in 1856 he said,

> ever since 1850 I have been amusing myself, at no small cost, in having analyses made of ancient glass, and have succeeded in discovering its manufacture. I gave the analyses to a glass manufacturer in this neighbourhood and with my scientific friends assisted him in reproducing the ancient material. I had first offered the

analyses to Chance of Birmingham, if he would work them out, but he refused, and this was fortunate, as I should not have been able to attend to the experiments as much as I did. The colours we have made are blue, the streaky ruby, several, but not all, kinds of green, yellow, white and a few shades of purple. The new material is as harmonious in colour, brilliant and at the same time solid in appearance as the old glass. Two windows, glazed with the new "old" glass have been placed in the round part of the Temple Church.

Most of the analyses were made by Dr Medlock of the Royal College of Chemistry. Winston, writing in the *Archaeological Journal* in 1857 on the colour of ruby-glass, said:

> it has been proved by experiments that the colour produced by adding copper, in the form of protoxide, to the materials of white glass, with which oxide of tin and oxide of iron have been mixed, is due to the presence in the glass, in very fine division, either of metallic copper or the protoxide.

This conclusion has been confirmed by the ultra-microscope in the recent researches of Garnett and of Zsigmondy.

The "Winston" antique glasses were shown in the Exhibition of 1862 and were described as similar to the coloured glasses of the thirteenth and fourteenth centuries. They possessed the solid effect of ancient glass, without the surface being subjected to any mechanical treatment.

The same works in which Winston's experiments were carried out have continued to produce a long series of coloured glasses for church windows. One of the most successful has been a "brown" ruby, formed by successive casings of manganese purple and gold-ruby on an antique white base. About 1880 E. J. Prior introduced a method of making small rectangular panes of coloured glass, by blowing it into an oblong iron mould. The base and sides of the oblong-shaped bulb form the panes, which, owing to the "ruffling" effect of the surface of the mould, have a brilliant effect. Sheet-glass in several colours is made by Pilkington Bros. of St Helens.

GLASS MOSAICS

From about 1870 attempts were made in London to produce a satisfactory palette of coloured opaque glasses or enamels for wall decorations and pavements. In 1875 a glass pavement was placed in part of the South Kensington Museum. In 1884 a mosaic translation of Raphael's "Disputa" was fixed on the east wall of the "Morning" Chapel of

St Paul's Cathedral, and in 1887 Holman Hunt's picture of "Christ with the Doctors in the Temple" was worked in mosaic to serve as reredos in the Chapel of Clifton College. The late Sir William Richmond's mosaics in the choir of St Paul's Cathedral were commenced in 1891. In this undertaking the modern Venetian method of working the mosaic in a workshop and fixing it in large slabs on the wall was not used, but the more ancient method was adopted of fixing the tesserae direct into a layer of cement spread on the surface to be decorated. As the work proceeded experience proved that a much more limited palette of colours was required than had been anticipated. It was found that in mosaics, placed well above the eye-level, every shade and gradation of tint can be obtained by the juxtaposition of suitably contrasted colours. Blue tesserae placed alongside green make the green bluer, whereas yellow tesserae make the green yellower. Red tesserae alongside of blue give a purple effect; white tesserae make red look pink and make gold tesserae resemble silver. These colour-effects are due to reflection from the surfaces of the tesserae, and the curious extension of the colour-effect of gold tesserae is similarly caused. If the cement be light in colour a wide surface will appear to be solid gold although each gold tessera may be surrounded by quite a wide margin of cement. The use of mosaic is best adapted for giving effects of permanent colour to spaces far removed from the eye.

COLOURED TABLE GLASS

In the 1851 Exhibition coloured table glass was only exhibited by Bacchus and Sons of Birmingham and Molineaux and Webb of Manchester. In the Exhibition of 1862, Richardson of Stourbridge showed opal vases painted with enamel, and Powell of London, vases in Venetian opal glass. The British milk-white glass of the latter part of the eighteenth century has been referred to in the section on Bristol glass-making. Early in the nineteenth century the use of colour for table glass was almost limited to wine glasses. The usual colours were ruby, bright green, emerald-green, purple, canary and yellow. Dark blue finger-bowls were also popular. About 1870 the Stourbridge glass-houses introduced the process of covering colourless or pale ruby table glass and vases with very closely wound glass threading of delicate tint. The "old gold" threaded glass had great success.

A later Stourbridge development was the cameo decoration of coloured glass vases, cased with enamel. In London the tendency was to disregard surface decoration but to produce table-ware, graceful and simple in form, in a series of delicately tinted glasses. The colourless Venetian opal of 1862 was succeeded between 1875 and 1900 by several shades of pale green and amber, straw opal, blue opal, amethyst, horn-colour, chameleon, sea-green and sky-blue. For a short time a transparent black found favour. Straw opal, introduced in 1879, proved to be well suited for shades for oil, gas and electric light.

Many attempts have been made, which have not yet been crowned with complete success, to produce a perfect glass for screening light in a photographic dark room and to provide a series of coloured glass light-filters for ortho-chromatic and three-colour photography.

Graduated tints of amber glass have been successfully made for comparative colour-tests of urine. A small demand has been met for a considerable number of coloured enamels for making artificial eyes. Human artificial eyes were exhibited by Pache of Birmingham in the Exhibition of 1851. The prolonged researches of Sir William Crookes (*Phil. Trans. Roy. Soc.*; Series A, Vol. 214, 1913) have shown that glasses containing certain colouring ingredients will effectually cut off all the ultra-violet and heat rays, which have been proved to be injurious to eyesight. A very pale salmon-coloured glass containing cerium cuts off ultra-violet rays, and iron, introduced into a glass mixture in the form of ferrous oxalate, almost completely cuts off heat radiation. The first meltings of these glasses, on a scale sufficient to produce experimental spectacles, were made in London, but their manufacture on a commercial scale has now been undertaken by Chance Bros. of Spon Lane.

CHAPTER IX

CAST PLATE-GLASS

SEVERAL references have been made to the manufacture of blown plate-glass for making mirrors. The plates (more correctly sheets) were made by flattening glass cylinders, which had been blown of sufficient thickness to allow for grinding and polishing the surfaces. The industry was derived from Venice, and Venetian workmen were brought over to teach the various processes both by Sir Robert Mansell and by the Duke of Buckingham. John Dawson, who became manager of Buckingham's Vauxhall glass-works, sent his son Edward to Venice to learn the secrets of the manufacture. Special clauses relating to looking-glass plates and glasses for coaches were included in the monopolies or patents granted to Mansell, Buckingham and Tilston. Blown plates were made at the Vauxhall, Bear Garden, King's Arms and Green-yard glass-works in London, and at Cookson's works in South Shields. The largest blown plate seems to have been about six feet square.

The making of small flat plates by pouring molten glass on to a flat surface was introduced by the Roman glass-makers. The manufacture of large plates by pouring the glass from a crucible on to an iron casting-table and rolling it flat by a large iron roller is due to the French, and was introduced in 1688[1]. When in 1773 the British Cast Plate Manufactory was founded, French workmen were brought over to the new works at Ravenhead near St Helens. In the Index to wills of the Lancashire and Cheshire Records Society the will of Jean B. Bruyère, plate-glass manufacturer, Ravenhead, is recorded in 1788. The manufactory, or company, was incorporated by special Act of Parliament, 13 George III.

[1] On 22 October 1775, Dr Johnson visited the Galerie des Glaces, in the palace of Versailles, completed in 1648. He describes it as "wainscotted with mirrours, not very large but joined by frames. I suppose the large plates were not yet made." On the following day he went to see large mirror plates wrought. "They came from Normandy in cast plates, perhaps the third of an inch thick. At Paris they are ground upon a marble table by rubbing one plate upon another with grit between them." *Life of Samuel Johnson, LL.D.*, by James Boswell, Esq.

Lord Mountstuart, the Hon. Major-General Charles Fitzroy, Admiral Philip Affleck and nineteen others were constituted the Governor and Company of British Cast-Plate Glass Manufacturers. Admiral Affleck appears to have been the moving spirit. The works at Ravenhead occupied thirty acres and were enclosed by a wall. The Act provided the penalty of transportation for a term not exceeding seven years for any person breaking into the manufactory with intent to steal or damage glass or tools. From three hundred to four hundred men were employed and in 1789 a steam-engine, "a very curious piece of mechanism," was erected to grind and polish the plates of glass. The processes of manufacture of the present time, although the mechanism has been greatly improved, are practically the same as those of 1773. The molten glass having been poured from a crucible on to the casting table is rolled flat by a heavy roller, and the plate when sufficiently set is pushed into an annealing kiln. Although the plate is flat, the surfaces of the plate, owing to the contact of the hot glass with the air, the casting plate, and the roller, are ruffled, and the glass is translucent but not transparent. In this condition it is known as "rough cast plate" and can be used for roofing and other purposes for which transparency is not required. In order to render the rough cast plate transparent, the ruffled surface must be ground away, and the effects of the abrasive materials used in grinding must be removed by polishing. The machines for grinding and polishing have in recent years been greatly improved, but the effects are still produced by mechanical rubbers moving over the glass fixed to a moving table. The grinding materials are first sand and water, and then emery and water: and the polishing material, rouge and water. The grinding rubbers are slabs of iron and the polishing rubbers are of wood covered with fine felt. Owing probably to heavy taxation the original company failed in 1798 but was bought up by the British Plate Glass Company. In the Excise List of 1835 the Ravenhead works appear under the name of John William Bell. The works cannot have been in a very flourishing condition as for the year 1833 the amount paid as excise duty was only £5035. 14*s*. 3*d*. T. Cockburn, governor of the company, in evidence before the Excise Commission stated that the ordinary dimensions of cast plates were about eight feet by five feet, and Isaac Cookson speaking for the works at South Shields said that plates could be cast up to twelve feet by seven feet. Reference was made to the great advantage possessed by French manufacturers in

being able to use wood for fuel, the coal smoke at times causing the glass to be discoloured. Isaac Cookson had commenced making cast plate-glass in 1813. The Thames Plate Glass Company was founded in 1835, and the London and Manchester Plate Glass Company in 1836. At the present time Pilkington Bros. of St Helens practically control the whole of the British plate-glass industry, as well as a large share of the sheet-glass industry. In 1826, two brothers, Richard and William Pilkington,

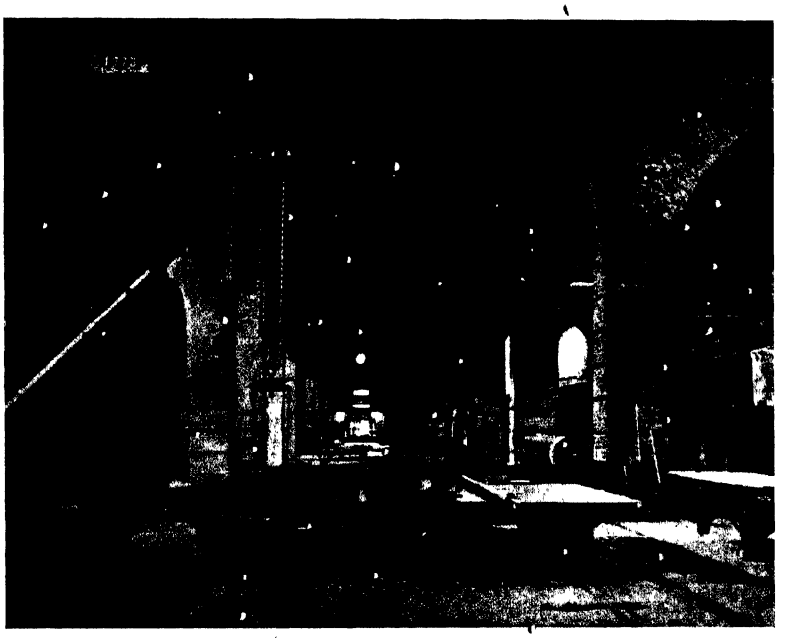


Fig. 89. Old Casting-Hall, Ravenhead.

started at a small factory known as the St Helens Crown Glass Works. The firm has now four large works, including the Ravenhead works of the original British Cast Plate Manufactory, and employs some ten thousand workpeople. Fig. 89 shows the old casting-hall of the Ravenhead works, built in 1773. The old processes have been modified and new developments introduced. The materials now used for making plate-glass are sand, imported from Belgium, salt-cake prepared and specially purified at chemical works forming part of the regular plant,

and limestone from Derbyshire. The melting furnaces are gas-fired, with a temperature ranging up to 1500° C. Each furnace contains twenty pots. The pots are open and basin-shaped; when full of glass a pot weighs about two tons. An impressed horizontal groove round the exterior of each pot facilitates its removal from the furnace. The old method was to melt the glass in large pots and to transfer sufficient glass for each casting by ladling from a large pot into a small casting pot or "cuvette." Now the large melting pots are themselves moved, and the glass poured from them. Each pot in turn is gripped by a large pair of tongs, extracted from the furnace and carried to the casting table. The casting table is covered with a very thin layer of sand and kept cool by water circulating inside it. When the mass of glass has been poured from the crucible, the roller passes over, spreads and flattens it. The cast plate, after remaining a few seconds to set, is ready for annealing. It is pushed into the first of a series of gas-heated ovens, each succeeding oven being slightly cooler than its predecessor and finally down a long leer. The temperatures of ovens and leer are controlled by pyrometers, and the process of annealing instead of taking four days, as previously was the case, can now be completed in four hours.

The glass plates, when annealed, are fixed with plaster of Paris on iron circular discs, which are rotated first in grinding- and then in polishing-machines driven by electric motors. When the surface of a plate has been polished it is removed and reversed so that the second surface can be similarly treated.

Cast plate-glass is made in many thicknesses from one-eighth of an inch for railway carriage windows to a couple of inches for ships' port-lights.

The King and Queen, when they visited the Cowley Hill Cast Plate Works in 1913, inspected all the processes from the initial casting to the final polishing of plates of glass. They were shown a silvered plate-glass mirror over two hundred feet square as well as specimens of the productions of the other glass-works belonging to Pilkington Bros. The specimens included crown-glass, as made by the Pilkingtons in the small St Helens glass-works in 1826, patterned, rolled "cathedral" glass, which is now made in the original Ravenhead cast-plate works, blown sheet-glass in all its stages, and an immense "drawn" cylinder, illustrating the first process of the most recent method of making glass for windows.

CHAPTER X

FLINT-GLASS

AN ANCIENT LONDON FACTORY

SINCE the year 1575, in which Jacob Verzelini, having started as a glass-worker in the great hall of the Crutched Friars in Aldgate, obtained a special licence from Queen Elizabeth on condition that he would teach her subjects the art and craft of making drinking-glasses, there has been an uninterrupted succession of City glass-workers. Stow's *Survey* of 1755 refers to fourteen glass-houses in the City and its immediate neighbourhood, but of these only one has survived, which is shortly to be removed in order to gain adequate space for expansion. These works, which date back to the last days of the seventeenth century, stand between Fleet Street and the River Thames, almost under the shadow of St Paul's, the City-fathers having been less timorous than those of Venice, who banished all glass-works and glass-workers to the island of Murano. The site is part of the area occupied by the church, house and grounds of the White, or Carmelite Friars, which, according to Stow, was bounded on the east by Water Lane, a section of which still remains, and on the west by the "New" Temple. Although the house was surrendered in 1538, the precincts continued to be a sanctuary, nominally for debtors, but in reality for criminals of all sorts and conditions. So valuable was the privilege that all available space was crowded with squalid dwellings, and such was the character of the inmates that peace-officers, unless in force, were afraid to cross the boundaries. The privilege of sanctuary was abolished by Act of Parliament in 1697, and notice was given that on a prescribed day the residents would be unearthed and hunted down. When at last the sheriff's army invaded the precinct it was found to be absolutely deserted.

Maitland in his *History of London*, 1756, states that "the precinct contains several courts, lanes and alleys, and that the yard, known as Davis' Yard, has been converted into a glass-house for making flint glasses."

Earlier references to the glass-house are contained in Nos. 208 and 230, *The Tatler*, 1710, and consist of advertisements of "all sorts of decanthers, drinking glasses and crewits, to be obtained wholesale or retail at the Flint Glass Works in White Fryars near the Temple." Such comprehensive advertisements suggest that the works were of some standing, and that they must have been built soon after the precinct was cleared. The site of the works is south of that of the main monastic buildings and north of a lane, now Tudor Street, running parallel with the bank of the river. North of the works part of an ancient groined crypt, evidently part of the monastery, has been discovered, and within the area of the works old chalk foundations have been found which may have formed part of monastic out-buildings. Before the formation of the Victoria Embankment the south side of Tudor Street was occupied by mean buildings with intervening lanes and alleys leading to the wharves and mud flats. The cheapness of land in an ill-famed district, and ready access to a wharf from which Newcastle coal, sand, clay, and other materials could be easily drawn, were probably the attraction to the first founder of the glass-works. The buildings at first were primitive, being little better than lofty sheds, to a great extent open to the street. The furnace cones were low and wide and sent out volumes of dense smoke. Quite recently the foundations of the old clay-mill were discovered, bordering on the highway, with a paved circular path for a horse, the only motive power. That the workers were also somewhat primitive, or that they had inherited some of the spirit of their Alsatian predecessors, is testified by a cutting from the *Whitehall Evening Post*, No. 2208, 1732:

> Yesterday a Press Gang went into the glass-house in White Fryars to press some of the men at work there, but they were no sooner got in but the (molten) metal was flung about 'em, and happy was he that could get out first, and in hurrying out they ran over their officer, who was almost scalded to death.

Mr Francis Buckley, to whom the writer owes the preceding extract, and who has made a prolonged study of the history of old London glass-houses, has compiled from London Directories the following list of former owners of the Whitefriars works. The first name in a Directory is Alexander Seal, 1738, but it has not been ascertained whether he was the original founder: Anthony Seal and Son 1749; Jonathan Seal 1752; Anthony Seal 1754; Hopton and Stafford 1763; Carey Stafford 1765;

Fig. 90. Glass blowing in South Furnace, Whitefriars, in 1895, showing workman's "chair" and tools.

1. Smith. 2. France. 3. Watkins. 4. Avery. 5. Grainger.

Hall and Holmes 1781; John Holmes 1791; William and Henry Holmes 1821; James Powell and Sons 1835–1919.

In the neighbouring church of St Bride a tablet commemorates Carey Stafford "many years Master of Whitefriars Glass Manufactory, died in August 1778." From 1745 to 1845 this and all other glass manufactories were subject to the payment of excise duty and to the regulations connected with it. Excisemen were quartered on the premises and it was their duty to interfere with every manufacturing process. No crucible might be put into a furnace, or filled with glass, and no glass might be removed from a crucible, except under the supervision of an officer of excise. The opening, closing and reopening of every annealing oven and the removal of every piece of manufactured glass were similarly supervised. Failure to carry out any one of hundreds of petty regulations rendered the manufacturer liable to a heavy fine, and he was entirely at the mercy of the supervising officers. It is a matter of surprise that any manufacturer could have tolerated such interference or that any manufactory should have survived it. Although the excisemen's sentry boxes have disappeared at the Whitefriars Works, bolts and locks of the excise pattern are still attached to some of the older annealing ovens, and iron gauging rods are preserved which were used in measuring the quantity of molten glass in each crucible at the beginning and end of each week for the purpose of taxation. The amount paid by the works as excise duty in 1833 was £3056, 6*s*.

Under excise regulations glass manufactories were divided into five watertight classes, and each class might only produce the kind of glass allotted to it. In order to evade the rule that flint-glass works might not produce glass for windows, either by blowing or rolling, the Whitefriars Works in 1844 introduced and patented a process of stamping, by mechanical pressure "quarries," small diamond-shaped panes of glass, for church windows. The roughened surface, caused by the contact of the iron mould with the molten glass, gave an effect of richness and brilliancy to these stamped quarries, and Mr Charles Winston, an authority on ancient painted windows, considered that they provided as good an imitation of the effect of ancient glass as could be obtained by any mechanical process. Believing, however, that the effect of ancient glass is really due to its chemical nature, he devoted himself to the study of the chemical composition of ancient coloured glasses, and his research

finally resulted in the reproduction at Whitefriars on scientific lines of the mediaeval recipes and methods of the Monk Theophilus.

The excise law relating to glass had been repealed in 1845, and the "Winston" colours in small crowns and sheets had been produced without hindrance. The manufacture has been continued and persistent efforts have been made to improve the glasses both in tint and texture.

Stamped quarries and coloured glasses naturally led to a search for artists who were willing and competent to make designs and drawings for windows in which the glasses could be used. D. G. Rossetti, who lived and worked in an old building overlooking the Thames and close to Whitefriars, was appealed to through Benjamin Woodward, the architect, and recommended Edward Burne-Jones and Ford Madox Brown. William Morris became interested, and although he did not at first make designs for glass, he assisted Burne-Jones in some of his cartoons, notably those for the east window for Waltham Abbey. Help was obtained from many other young artists, amongst whom were Edward Poynter, William Riviere, James Doyle, Henry Holiday, H. S. Marks, Albert Moore, William de Morgan and H. S. Wooldridge. The earliest "Burne-Jones" windows were placed in the dining-hall of Bradfield College in 1857. A panel of the Waltham Abbey window, containing the figure of Jesse, was shown in the International Exhibition of 1862. Specimens of Sir Edward Poynter's early work in painted glass are in the Church of St Bartholomew the Less, which serves as Chapel for St Bartholomew's Hospital. In recent years, the most important painted glass produced at Whitefriars has been the great east window and the windows for the Lady Chapel of Liverpool Cathedral, and the series of seven three-light apsidal windows for the Cathedral of St John the Divine, New York, which form a band of intensely glowing colour.

Fig. 91. Burne-Jones' first cartoon for glass, 1857.

At the present time there are hundreds of varieties of glass, differing from each other in chemical composition. To this list the Whitefriars Works have contributed a fair share. The advertisement of 1710 refers to two varieties of flint-glass, "best" and "ordinary": unfortunately the

recipes have disappeared, but the two kinds probably differed in the quality of sand, or in the proportion of red-lead. Until the hampering excise regulations had been withdrawn, little could be done towards the scientific development of the industry. It is, however, recorded that in 1837 a pair of glass girandoles, coloured yellow by the addition of a salt of uranium to the ordinary flint mixture, were presented to Queen Adelaide. In 1840 Dollond the optician was supplied with thick slabs

Fig. 92. The first experiment in mosaic in the old method, 1865.

of lead-potash glass for the manufacture of lenses for telescopes. The glass used for the stamped quarries for windows was not a new variety, but merely flint-glass, too much discoloured to be worked into table glass. The base of the "Winston" colours was a glass free from lead, but containing lime and magnesia. The most interesting of these glasses are the ruby, due to copper, and the pale blue, due to iron. Experiments were constantly carried out to test the colour effects of all sorts of colouring agents, and a long series of delicate tints suitable for table and decorative glass were produced. A colourless opalescent glass, similar to

Venetian opal, was first shown in the Exhibition of 1862; this was followed later by a pale blue and a straw-coloured opal, and by transparent tints of pale green, sea green, amber, horn-colour, chameleon, black and "Selenium" orange. Transparent, soda-lime glasses, both colourless and tinted, based on analyses of Venetian and ancient Roman specimens, were worked, as well as glasses for scientific purposes, possessing special chemical qualities. Dense white enamel was made for forming the index line in thermometers and was exported in the form of thick cakes to be used in Switzerland for enamelling watch dials. Domestic ware, however, has always been the staple manufacture: it is unfortunate that not even fragments remain of the decanters, drinking glasses and cruets advertised in 1710.

Two heavily cut chandeliers, which have survived from 1788, suggest that at that time cutting as a decoration of table-ware may have played an important part. In the 1851 Exhibition cut chandeliers and cut and engraved table glass were shown, as well as glass conduit pipes[1] for water and gas, and some laboratory glassware. One of the table-glass services was decorated with deeply cut, imbricated, natural leaves. In the Exhibition of 1862 a feature was made of table-ware, engraved with natural ferns, but glass tubing, water pipes, optic plate, coloured glasses for church windows, and glass jars for museums were also exhibited. For over seventy years the British Museum, in spite of German competition, has been supplied with large stoppered jars for the storage of specimens of natural history. In nearly every Exhibition which has had a Section of Arts and Crafts, from the time of the Crystal Palace in Hyde Park to the Exhibition in the Pavillon de Marsan at the Louvre in 1914, "Whitefriars" table-ware has been represented. Philip Webb, who in 1859 designed the table glass for William Morris for the Red House (Fig. 29, A, B), was the first artist to insist that simple beauty of outline is the essential decoration of a drinking glass. In Mackail's *Life of William Morris* it is recorded that when Morris, Marshall and Faulkner opened their showroom in Red Lion Square, some of Webb's glasses, made at Whitefriars, were the first things sold. In 1874 T. G. Jackson (now Sir T. G. Jackson, R.A.) designed a complete service on somewhat similar lines (Fig. 81). About 1880 were produced the Whitefriars "poppy head" decanters and a series of wine glasses with slightly curved bowls and

[1] These were intended to replace the original wooden conduit pipes for his supply of water.

hollow legs, delicately twisted. The introduction for table-ware of very light surface-cutting, copied from ancient Roman examples, dates from 1884. It was not until 1879 that it was realised that shades for oil-lamps and gas-jets might vary from the globular form and might be coloured. In that year the gas-burners of the Haymarket Theatre were screened by tinted glass shades, not globular in form.

An economical desire to prevent waste led to the development of the craft of mosaic. It had been the custom to scrap as useless all fragments of flint-glass contaminated with clay, but experiments proved that this

Fig. 93. Reredos in the chapel of Clifton College, from Holman Hunt's specially prepared cartoon, worked in the studio in sections.

waste glass, if ground to a fine powder and baked, yielded a solid, durable material with an eggshell surface suitable for wall tiles and mosaic, and that the range of colours was almost unlimited. This material was used in 1884 for a reproduction in fine mosaic of part of Raphael's "Disputa" on the east wall of the Morning Chapel of St Paul's Cathedral, and in 1887 for a translation in mosaic for the reredos of the Chapel of Clifton College of Holman Hunt's picture of "Christ among the Doctors."

Sir William Richmond's mosaics in the choir and choir-aisles of St Paul's, which were commenced in 1891, were worked in coloured enamels, similar to those used in the ancient mosaics of Rome and Ravenna. A full palette of enamel colours was prepared, together with

a reliable, non-blackening, slow-setting cement. The slow-setting quality was necessary because the tesserae were fixed directly into cement spread on the actual structure of the cathedral, and alterations were not infrequently required. Once whilst working in one of the shallow, saucer

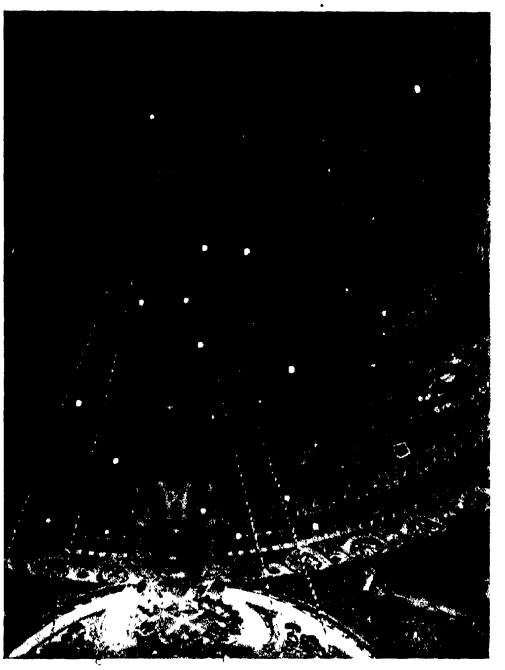


Fig. 94. Easternmost saucer dome in the choir of St Paul's Cathedral, designed by Sir W. B. Richmond, R.A., 1892, worked *in situ*. The photograph shows the ropes supporting the platform on which the mosaicists stood

domes of the choir, the mosaicists received an unannounced visit from H.R.H. Alexandra, Princess of Wales, who in spite of the laborious climb to the cornice and to the wire-suspended scaffold, insisted on personally inspecting the details of the work. There are records of several informal visits of royalty to the Whitefriars furnaces. Early one morning, the late Princess Royal and the Emperor Frederick were found engrossed in watching the blowing of a giant goblet.

Perhaps one of the most interesting and interested visitors to the works was John Ruskin. He showed a curious liking for brilliant and crude colours, and he recommended Miss Kate Greenaway as a designer for painted glass, whose drawings were singularly ill-adapted for glass

Fig. 95. The Potter. In the south side of the choir of St Paul's Cathedral, designed by Sir W. B. Richmond.

technique. In the studio he took off his hat before the laboured and ineffectual drawing of a very young artist, because the effort bestowed upon the shading of an angel's wings, for a window to be fixed at a great height from the ground, although unseen by men, would be appreciated by angels in heaven.

This is not the place to deal with the human element of the ancient factory. From the first the relationship between employers and employed has been somewhat patriarchal, son succeeding to father in the management, and fathers, sons and grandsons working together at the

Fig. 96. Head of the Potter (from Fig. 95) enlarged to show tesserae.

furnace. There is, however, one outstanding personality which deserves some record: Joseph Leicester, craftsman, social reformer, and Member of Parliament. A glass-blower by inheritance, he started work at the furnace at nine years of age. Although his education, at an old-fashioned parish school, had been scanty, he was a voracious reader, possessed a close acquaintance with the English classics and works on economics,

and had accumulated a considerable library. An ardent trade unionist and temperance reformer, his views were sane and moderate. In 1866 he was a leader in the great Reform demonstration, and saw with some consternation the unexpected collapse of the Hyde Park railings. He was sent by the Society of Arts to the Paris Exhibitions of 1867 and 1878 as a representative of British Craftsmanship. He was a superb workman and inspiring teacher, and when in 1885 he gave up the furnace for the House of Commons, he left behind a tradition of good work and wise counsel and a reputation for having excelled in his craft the famous Venetian who first taught the perfect art of glass-blowing in London.

CHAPTER XI

CUT-GLASS[1]

CUT-GLASS, as an English craft, has never received adequate and sympathetic treatment.

In the early Victorian period cut-glass was exceedingly popular, but the craft, like most other artistic crafts, was debased. About the middle of the reign it lost its popularity, and, although for some time past admirable specimens have been produced, it still remains the Cinderella of the artistic crafts. Other crafts have suffered similar eclipse, but have regained popular favour and artistic recognition, but cut-glass is, at the best, regarded with sufferance, and to the aesthetic soul is still a thing accursed. The continued aesthetic ban on cut-glass is a striking testimony to the persistence of Ruskin's influence, and it is all the more remarkable, if it can be proved that he denounced a craft without possessing adequate knowledge and without sufficient consideration. In the twelfth appendix of the second volume of *The Stones of Venice*, Ruskin writes as follows:

> The workman has not done his duty and is not working on safe principles unless he so far honours his materials as to bring out their beauty and to recommend and exalt their peculiar qualities. He will invariably find the material grateful and that his work is all the nobler for being eulogistic of the substance of which it is made. But of all the arts the working of glass is that in which we ought to keep these principles most vigorously in mind....The peculiar qualities of glass are ductility when heated, and transparency when cold. In its employment for vessels we ought always to exhibit its ductility, and in its employment for windows its transparency. All work in glass is bad which does not, with loud voice, proclaim one or other of these qualities. Consequently all cut glass is barbarous, for the cutting conceals its ductility and confuses it with crystal.

Ruskin's low opinion of the artistic value of glass-cutting as a form of decoration may, or may not, be justified, but it has been a contributory cause of the neglect and dispersion of collections which were formerly as highly valued as collections of china, and has increased the difficulty of the investigator.

[1] Based on a paper read before the Society of Arts, 29 May 1906.

The first step towards collecting material for this paper was the issue of a circular to persons and public bodies, in whose possession it was thought there might be specimens of eighteenth century cut-glass. The replies to the circular from Ireland proved that Ruskin's influence had little effect in that country, and that Irish householders were proud of their collections of Irish cut-glass.

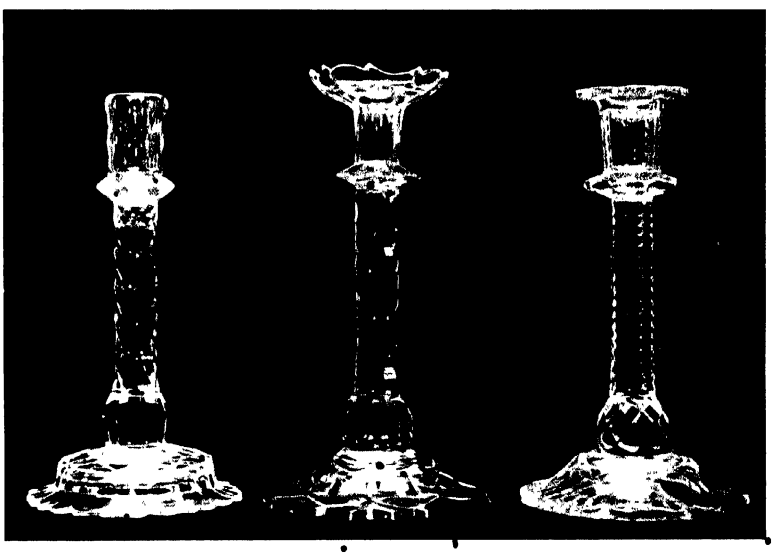


Fig. 97. Cut-glass candlesticks, late eighteenth century.

The English replies have been disappointing. The historic houses, with hardly an exception, possess no cut-glass. Of the colleges of Cambridge, Clare possesses two cut-glass cruets or vases, and of the colleges of Oxford, Christ Church possesses one cut-glass mustard-pot and one glass jug.

Of twelve of the leading City companies, the Drapers' Company is the only one which acknowledges the possession of any old cut-glass, and nothing is known about the origin of the three fine decanters which have been preserved. Even in the national and provincial museums cut-glass is very inadequately represented. The British Museum has no eighteenth century cut-glass, the Victoria and Albert Museum has a

small collection and the Guildhall Museum has no specimens. The Bristol Museum possesses a few pieces of cut-glass which are said to have been made and cut in Bristol. The museums of Bath, Birmingham, Glasgow, Newcastle and Sheffield either have no specimens or, if they have, nothing is known about them.

Fig. 98. A table-light or girandole, about 1790.

The history of cut-glass commences at the beginning of the Christian era under Roman influence. The Romans certainly brought the craft to a high state of perfection, and no later craftsmen have so accurately gauged its limitations and its possibilities. Roman cut-glass is well represented in the British Museum and in the museums of Cologne and Nuremberg.

Pliny, in Book XXXVI of his *Natural History*, very accurately defines the process of glass-cutting as distinct from carving, he says: "Aliud

torno teritur, aliud argenti modo coelatur," which may be thus freely translated: one kind of decoration is cut into the glass by means of a revolving wheel, the other is carved with a tool similar to a silversmith's graving-tool.

Except for changes in detail, the modern process of cutting is identical with that described by Pliny in the middle of the first century. A wheel or disc of iron or stone on a horizontal axle is caused to revolve by the

Fig. 99. Chandelier (restored) about 1750, showing some flat angular pendants.

human foot, by water power, by steam or by electricity. The wheel is fed with sand and water or water alone, the glass object is pressed by the workman against the edge of the wheel and a groove or mark is produced. The workmen, by moving the glass object whilst in contact with the wheel, can produce curves, and by combining lines and curves can produce patterns. After the patterns have been cut, the roughened surfaces are polished by pressing the glass against a wooden wheel fed with putty-powder and water. The process sounds exceedingly simple but, in reality, requires skill of a very high order.

The Roman cutters seem to have had no immediate successors. The

craft either died out altogether or passed from Rome to Constantinople. Chronologically the next form of cutting which is known, is that applied to the strange tumbler-shaped vessels, called Hedwig glasses, deeply

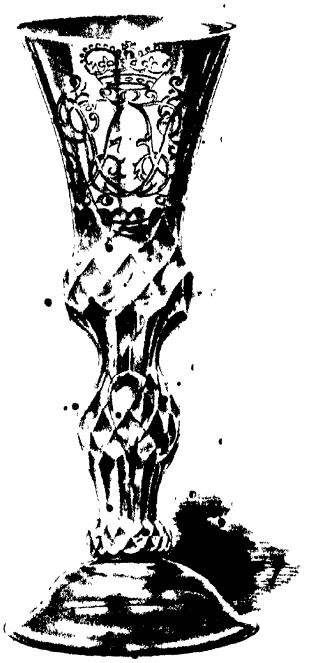


Fig. 100. Thistle-shaped glass. Before 1751.
From Hartshorne's *Old English Glasses*.

and rudely cut with representations of mythical birds and beasts. They are supposed to have been made and cut in Constantinople in the twelfth and thirteenth centuries.

After the taking of Constantinople by the Turks in 1453 there was a renaissance of glass-cutting in Italy. The style differed from the old Roman cutting, the cutters having evidently been trained in the art of cutting rock-crystal and gems.

At the end of the sixteenth century, Rudolph II introduced Italian cutters from Milan to take control of the crystal and glass-cutting works he had established at Prague. From Prague the craft spread to Nurem-

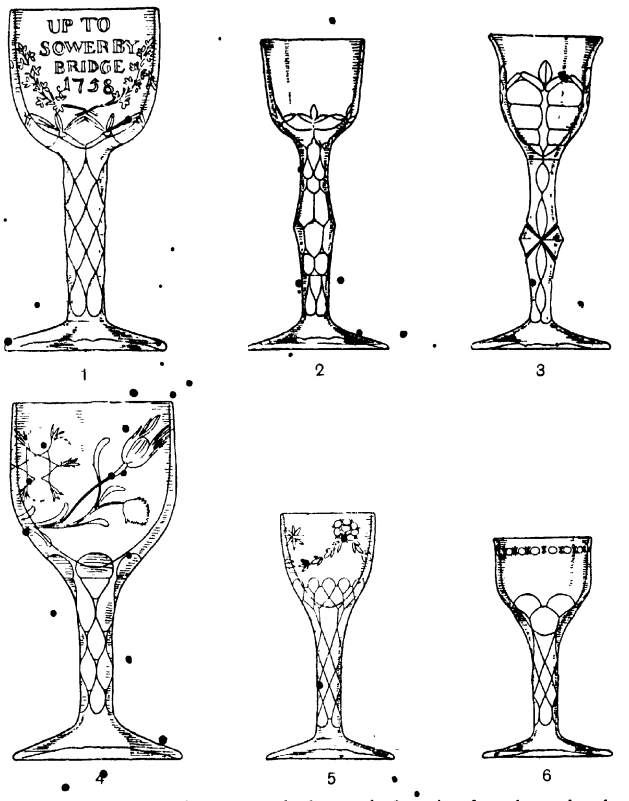


Fig. 101. Examples showing gradual spread of cutting from leg to bowl. From Hartshorne's *Old English Glasses*.

berg and was well and firmly established in Germany long before any attempt at glass-cutting was made in this country.

The introduction of glass-cutting into England may be traced to the proclamation of 1615 which prohibited the use of wood as fuel in glass-furnaces. The use of coal led to the introduction of covered crucibles

(glass pots). The loss of heat due to the exclusion of the direct action of the fire led to a search for a flux which would enable the glass-mixture to melt at a lower temperature without any sacrifice of the durability of the glass. The old mixture, for the so-called crystal-glass, was sand, lime, soda and some potash. A very small proportion of oxide of lead had been added as a flux but was supposed to make the glass brittle. The development of English flint-glass arose from successive increases in the proportion of the oxide of lead, its gradual substitution for lime and the

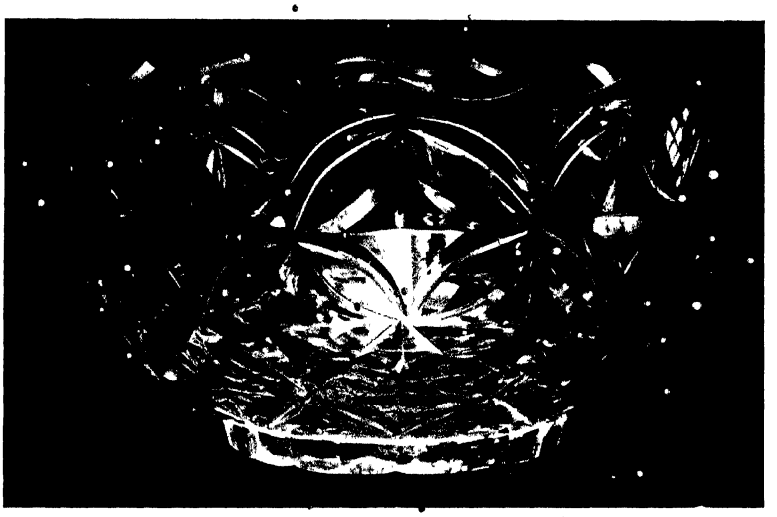


Fig. 102 Cut-glass bowl, about 1780.

gradual replacement of soda by potash. It was a slow growth not a sudden discovery. This slowly developed glass, although not always colourless, proved itself to be more brilliant than any form of Bohemian or Venetian glass. The power of breaking up light into its constituent colours is in direct proportion to the density of the translucent material through which the light passes. The density of glass of lead ranges from 3·2 to 4·0; the density of German glass is about 2·5; that of rock crystal is 2·6, and that of the diamond is about 3·5. The density of glass of lead approaches, and in some cases exceeds, that of the diamond, and it rivals the diamond in the production of prismatic displays. To this property

has been due both the pre-eminence and decadence of English cut-glass.

M. Peligot, a French authority on glass, and certainly unbiased, has written as follows on the subject of "glass of lead": "To the English should really be attributed the honour of having created in their flint-glass a new product...which is the most beautiful glassy substance we know." Gerspach, in his *History of the Art of Glass Making*, which is mainly devoted to a description of glass-making in France, says:

> The English glass which entered into competition with the Bohemian glass, in the middle of the eighteenth century, dealt a deadly blow to Bohemian colourless glass. The English material lent itself to facet-cutting infinitely better than the Bohemian, and beat the Bohemian glass, as that had beaten Venetian glass. It became the rage in all the continental cities and eclipsed the Bohemian cut glass.

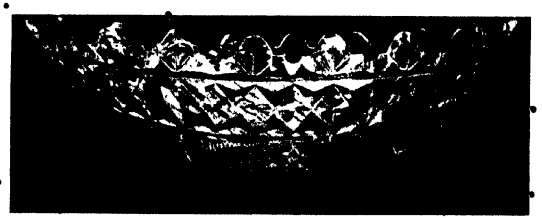


Fig. 103. Cut-glass bowl, about 1780, from the *Encyclopaedia Britannica*. Dublin Museum.

It is doubtful whether any other English craft has obtained such a testimony from a rival nation, and it is strange that so few records remain in England of a craft which, abroad, obtained such ample acknowledgment.

Glass-cutting had been introduced into Germany in the seventeenth century, and in due course specimens of German cut glass found their way to this country. There is no proof that any glass was cut in this country before the beginning of the eighteenth century. At that time English glass-workers had examples of German cut-glass to copy, and possessed a glass superior in quality to that known as Bohemian crystal.

The earliest specimen of English cut-glass in Mr Hartshorne's collection, the date of which can be approximately fixed, was a thistle-shaped glass, bearing the monogram of Frederick Prince of Wales, father of George III (Fig. 100). Frederick became Prince of Wales in 1729

and died in 1751. If this is a genuine English glass the records of English cut-glass may, therefore, be said to commence early in the eighteenth century. The best period of the craft is between 1750 and 1810, from which date its decadence was rapid. Thanks to Mr Hartshorne a useful and suggestive succession list has been formed, based on the shapes and cutting of the bowls and stems of wine glasses (Fig. 101).

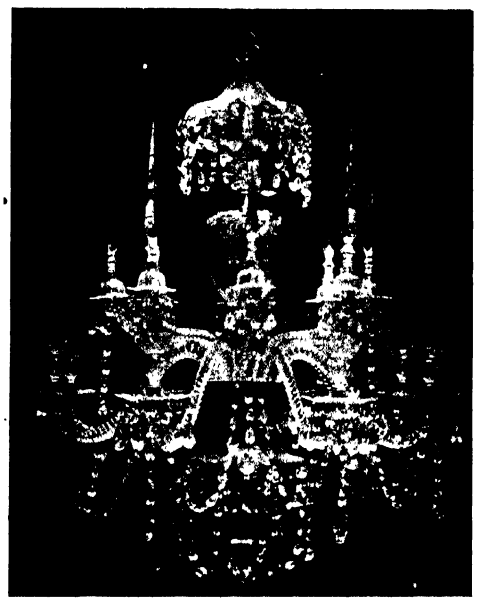


Fig. 104. Chandelier, about 1780.

As similar cutting occurs on other objects this list can, to a certain extent, be applied to English cut-glass generally. At the head of the list he places glasses with thistle-shaped bowls. This shape was copied directly from a Bohemian model, although at the present day Scotch glass-makers claim it as a special invention of their own. The thistle-shaped bowl was soon superseded in England by a straight-sided tumbler-shaped bowl. The stems were straight and cut with facets, the termination of the facets at the base of the bowl being crowned by deeply cut three-leaved sprays. Some large punch glasses of this character (Fig. 101 (1)) are preserved at Field House, Sowerby, the property of the Stansfeld

family. The glasses are engraved with an inscription commemorating the passing of the Calder and Hebble Navigation Act in 1758. It is supposed that the Stansfeld glasses were made and cut in Newcastle. The straight stems were succeeded by hexagonal-knopped stems, the top facets being still crowned with three-leaved sprays. In later glasses of

Fig. 105. Chandelier, 1788.

the same group the cresting is moved more than half-way up the bowl. At the end of the century the facets developed into long flutes, the cresting disappeared, and the tumbler-shaped bowls lapsed into the tapered or semi-tapered bowls of the wine glasses of our grandfathers. Cut glasses, with heavy squared feet, came into existence in the early years of the last century.

There is a common belief that certain styles of cutting indicate certain dates. It is true that a certain style may indicate that a glass was not made before a certain date, but a style, once introduced, was constantly copied, and the copying is still continued. Copying may be legitimate or illegitimate. The latter process is known as "faking." Some faked

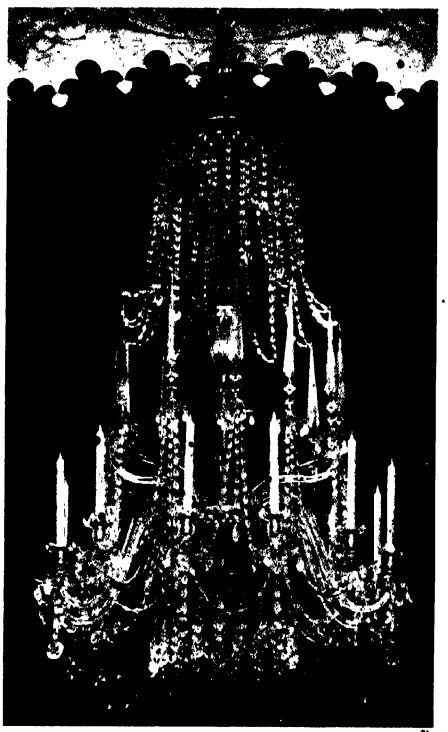


Fig. 106 Chandelier, 1804.

glasses are self-evident, but a glass may be so scientifically faked that its discovery is exceedingly difficult. The workmanship, the weight, the colour, the feel, the ring and the wear of a glass are signs, but are signs which can be imitated. The only glasses about which one can be perfectly sure are those which have been handed down as heirlooms, and those about which an accurate record in writing has been preserved.

Mr Hartshorne's succession list, suggestive as it is, is more useful to

the collector than to the craftsman. A chronological table is needed, applicable to all forms of cut-glass, and based on the relation of cutting to form. It might be divided into three periods: the first containing the glasses in which cutting is subservient to form; the second that in which the claims of form and cutting are equally balanced; and the third that in which cutting is the predominant partner. The first two periods date from the abandonment of German models, the cutting of which was based on rock-crystal cutting, and lasted to about 1810, and the third period has not yet terminated.

English cutters were led astray by the softness and the refractive power of their glass. They found that as they cut deeper they obtained greater prismatic effects, and at the same time greater profits from a dazzled and fascinated public. Deeper cutting necessitated thicker glass, and the triumphs of the third period are objects of great solidity bristling with prismatic pyramids.

Hartshorne's *Old English Glasses* is practically limited to the consideration of wine glasses and goblets, but cutting was applied to all forms of table-ware and decorative glass: decanters, cruets, finger-bowls, flower-bowls, epergne-dishes, candlesticks, wall-lustres, girandoles and chandeliers[1]. The earliest English chandeliers belonging to the middle of the eighteenth century were modelled on those in the palace of Versailles and had flat angular drops or pendants (Fig. 99). Cut-glass arms, at first deeply notched, but subsequently with plain flutes, were substituted for the metal arms of the French chandeliers, and the whole framework was gradually clothed in glass. The French flat pendants were replaced by pear-shaped, richly faceted drops, which may be claimed as characteristic of English lustre work.

The chief centres of glass-cutting in the eighteenth century were Birmingham, Bristol, London, Stourbridge, Whittington (near Chesterfield) and Waterford. The latter is included with the English factories because the Waterford works were started, as Mr M. S. D. Westropp has pointed out, with a complete staff of glass-workers from Stourbridge.

Birmingham. A Birmingham directory of 1781 contains the name of Isaac Hawkes, glass-cutter, who subsequently erected a furnace for

[1] 18 September 1777. "Last night Dr Johnson had proposed that the crystal lustre or chandelier in Dr Taylor's large room should be lighted up." Boswell's *Life of Dr Johnson*.

making flint-glass. Mr Frederick Bradbury, in his *History of Old Sheffield Plate*, gives a list of glass-makers and cutters from whom, between 1779 and 1812, Fenton and Co. and Bradbury and Watson obtained their cut-glass for mounting. In this list are Isaac Hawkes, and Hughes and Harris of Birmingham.

Bristol. The Phoenix Glass Works, of Temple Gate, Bristol, with which the name of Ricketts is connected, were erected in 1785. Henry Ricketts and Co. were noted for their cut-glass.

London. The demand for cut-glass would naturally be largest in London, and there is reason to believe that in the eighteenth century London was the most important centre of glass-making and glass-cutting. In the London Directory of 1753 two glass-houses are mentioned, famous for cut-glass, one at the Falcon Stairs, Southwark, belonging to Mr Jackson, "glassman," which afterwards became identified with the name of Pellatt, and the other, on the other side of the river, occupying part of the site of the house of the White Friars, and owned by Anthony Seal. Anthony Seal was succeeded by Carey Stafford, and Carey Stafford was succeeded in 1781 by Hall and Holmes. The Directory of 1771 gives the name William Parker, glass-seller, 69, Fleet Street. In 1784 the title of this shop was William Parker and Sons, glass-manufacturers to H.R.H. the Prince of Wales. The firm of Parker and Sons, afterwards known as Perry and Parker, obtained their cut-glass from the glass-factory on the north side of the river as well as from that on the south. Mr F. A. Newdegate, of Arbury, Nuneaton, possesses two exceedingly fine eighteenth century chandeliers, as well as other glass of the same character. On looking over some old papers he discovered not only the bill for a chandelier supplied by Perry and Parker, of 69, Fleet Street, in 1804, but letters and copies of letters concerning the whole transaction. There is a copy of a letter from Sir Roger Newdegate enquiring the price of a chandelier similar in design to two eight-light lustres supplied in 1788, but to be for twelve lights. There is also a letter in reply from Perry and Parker, dated 17 October 1804, saying that they have in their drawing-book a sketch of the lustres sent in 1788, but they recommend that the branches of the new chandelier be cut plain, as "plain arms have succeeded those cut with hollows, and are more generally approved." The large twelve-light chandelier at Arbury (Fig. 106) is probably, for metal and design, one of the finest in England.

Ruskin has said that "cutting obliterates the ductility of glass," but no form of manufactured glass can more forcibly proclaim ductility than the long, sweeping arms of this magnificent chandelier.

Stourbridge. The Brierley Hill Glass-works of Stourbridge founded by Richard Honeybourne in 1785 have been continuously noted for cut-glass.

Whittington. From 1779 to 1807 there are records of supplies of cut-glass to the Sheffield Plate-workers from the Whittington Glass-works. They were established in 1704 by Richard Dixon, who migrated from the Bolsterstone works. Hartshorne gives extracts from invoices for table glass from John Dixon, of the Whittington Glass-house, near Chesterfield, to J. Sitwell, Esq. The invoices range from 1791 to 1793. They are, amongst other things, for "neat, Rodney, cut-neck, decanters," for finger-cups with cut bottoms, and for a cut "shandilere." John Dixon was grand-nephew of Richard Dixon.

Waterford. Mr Westropp, the recognised authority on Irish cut-glass, has permitted the author to quote the following particulars about the Waterford works from his introduction to the Catalogue of Glass in the Dublin Museum. The *Dublin Evening Post*, 4 October 1783, announced that George and William Penrose had established on the Quay, Waterford, an extensive glass manufactory for making all kinds of plain and cut-glass.

In 1785 John Hill, a glass-manufacturer of Stourbridge, brought to the Waterford works the best set of glass-workmen obtainable in the Stourbridge district.

In 1802 a new glass-house was erected in Anne Street.

In 1811 Jonathan Gatchell, who had obtained the secret of mixing glass from John Hill, became sole proprietor. The successive names of the firm were: 1783, George and William Penrose; 1799, Ramsey Barcroft and Gatchell; 1811, Jonathan Gatchell; 1823, Gatchell and Walpole; 1842, George Gatchell and Co.

The chief products of the Waterford works were chandeliers, candelabra, salad bowls, jugs, decanters and drinking glasses. There are the remains of a fine chandelier in the Waterford Council Chamber which was put up in 1802.

In 1851, after an existence of only 68 years, the works were closed.

In the museum catalogue, referred to, only two specimens of cut-glass are definitely allocated to Waterford.

Waterford glass is said to possess a greyish-blue colour. All the flint-glass of the eighteenth century, both English and Irish, was liable to accidental colour, owing to impurities in the raw materials. Mr Westropp states that in his experience Waterford glass is freer from colour than that of the other Irish glass-works. The raw materials of the eighteenth century flint-glass makers were sand, litharge or red lead, carbonate of potash, saltpetre, a small proportion of white oxide of arsenic and a still smaller proportion of black oxide of manganese in the form of the natural ore, pyrolusite. The two latter substances were used to disguise or counteract the green tint caused by iron, an almost constant impurity in sand. It must be remembered that the mixing in those days was guided by rule of thumb and not by chemical analysis. The theory that the grey colour of so-called Waterford glass is due to impurities in the litharge is improbable. The more probable source is the impure oxide of manganese, which was used as a decolorising agent. Some specimens of pyrolusite contain minute traces of nickel and cobalt which, with manganese, would produce the characteristic greyness. In the glass itself the proportions of these metals would be so extremely minute that they could easily be overlooked. The variation in the quality of the pyrolusite accounts for the variation in the colour of the glass.

A study of old cut-glass proves that the object has been to give expression to one of the essential qualities of glass, namely its inherent brilliancy. That this quality should always be coyly hidden under an unbroken surface seems to be a wanton waste of decorative effect. Cutting applied in such a way as to proclaim the brilliancy of glass, without obscuring or cloaking the form given by the glass-blower's breath, helps to illustrate an essential quality of the material, and should no longer be regarded as barbarous. The cutting which most closely corresponds with the spirit of the new law is that of the Romans. Their system of lightly breaking the surface to dispel monotony and obtain flecks of brilliancy is the system from which cutters of modern table glass should draw their inspiration.

CHAPTER XII

THE EXCISE PERIOD

IN glass-houses which have survived from the early part of the nineteenth century tangible relics may be found of the machinery employed to enforce the payment of the excise duty on glass. The entrance doors of annealing kilns and "leers" are fitted with cumbrous locks, and the rooms into which the "leers" open and where the annealed goods are removed and examined resemble prison cells except in the fact that access from the outside is more difficult than egress. Iron instruments will also be found which were known as "dipping" or "gauging rods," and which were used to measure the amount of molten glass contained in the pots: in the words of the Regulations, "to measure the depth of the vacuity above the surface of the metal."

The sites only remain of the sentry-boxes in which the "officers of excise" spent such part of their time in sleep as was not occupied in harrying the works' managers or being harried by the glass-house boys. Two, at least, of these officers were quartered in every glass-works, and as the duty was payable partly on the worked and partly on the unworked glass, it was their business to register the total weight of glass melted and to prevent the removal of any piece of manufactured glass which had not been weighed. A manufacturer, in his evidence before the Commissioners of Excise in 1833 gave the following description of the internal condition of a glass-factory under excise regulations:

> Our business and premises are placed under the arbitrary control of a class of men to whose will and caprice it is most irksome to have to submit and this under a system of regulations most ungraciously inquisitorial. We cannot enter into parts of our own premises without their permission; we can do no one single act in the conduct of our own business without having previously notified our intention to the officers placed over us. We have in the course of the week's operations to serve some sixty or seventy notices on these, our masters, and this under heavy penalties of from £200 to £500 for every separate neglect.

On the same occasion, Lucas Chance, of Chance Brothers, said with reference to the compulsory notices: "These are so numerous that I

have them printed by the thousand: we have to give notices all day long." In spite of all precautions there was evasion of duty both within the licensed factories and to a still greater extent in small "pirate" factories. In all large towns there were numbers of these "little-goes" hidden in back yards and cellars, where broken glass was re-melted and converted into small goods, which could be sold cheaply but at considerable profit owing to the non-payment of duty. The value of these goods in London alone in one year was estimated at £65,000.

The Commissioners in their own summary of the results of their enquiries made the following statements:

> (1) That in their opinion evasion of the duty could not be prevented by any addition to the laws or regulations; (2) that the regulations presented a great impediment and in many cases a complete bar in the way of those experimental researches which are necessary for the adequate pursuit of objects connected with some of the most important branches of Science; and (3) that they also operate as a direct hindrance to our successful competition in the glass trade with foreign countries.

Mr Poulett Thomson in a speech in the House of Commons in 1830 on the excise duty on glass said: "This miserable duty amounting to only £500,000 and on which a charge of 10 per cent. is made for collection, is allowed to impede our native industry, and to put a stop to all improvements and to be a source of endless oppression and fraud."

The duty was first tried in 1695, but was speedily withdrawn as being "vexatious and troublesome in the levying and of small advantage to the Crown." It was reimposed in the reign of George II and was not finally repealed until 1845. The amount of the duty and the regulations were repeatedly modified, but the general system remained practically unaltered.

The imposition of the excise duty was accompanied by a tax on all glass imported from abroad, and from the evidence given before the Excise Commissioners in 1833 it is clear that whereas all manufacturers desired a reduction in the amount of this duty, many felt that the retention of some duty was preferable to the risk of losing protection. There were three payments under the excise. (1) An annual payment for each glass-house, practically for each furnace, for a licence to manufacture glass. (2) A payment per pound for all glass melted in the glass pots and ready for use. The weight was arrived at by calculations based on the

internal dimensions of each pot and the surface level of the molten glass within it, and (3) A payment per pound on the excess in weight of manufactured glass over 40 per cent. (or later, 50 per cent.) of the calculated weight of molten glass. There were certain allowances for spoiled glass, and for glass broken during annealing.

The regulations provided that the internal dimensions of every glass pot must be registered, and that every annealing oven and leer "must be rectangular in form, with only one entrance, and with a sufficient iron grating affixed thereto, together with proper locks and other fastenings for securing the same." It was necessary to notify the excise officers before any pot was heated or filled, and before any annealing oven or leer was heated, as well as before it was closed and before any goods were removed from it. The whole industry was divided into five water-tight compartments, and no overlapping was allowed. Flint-glass might not be made in a crown-glass factory, nor bottle-glass in a plate-glass factory. A common bottle-glass factory might not produce phials less in content than six ounces. A crown or German sheet-glass factory might not produce glass exceeding one-ninth inch in substance, and a plate-glass factory must not produce plates exceeding five-eighths inch or less than one-eighth inch in thickness.

The excise duty on glass was not imposed in Ireland until 1825, and up to that date the Irish glass industry had prospered. Charles Mulvany, an Irish glass-manufacturer, in his evidence before the Excise Commissioners in 1833, said that there was no importation of glass into Ireland before the imposition of the duty. Martin Crean, another manufacturer, attributed the decline of the industry to the excise duty. "Whereas before its imposition there were in Dublin four extensive glass manufactories, only one was at work in 1833."

It appears that in that year the duty paid on glass throughout the whole of Ireland only amounted to £22,399, less than half the sum paid by a single large manufactory in England. By 1851 glass manufacture in Ireland, on any appreciable scale, had ceased. The excise killed the industry in Ireland and greatly retarded its development in England and Scotland.

We are, however, indebted to it for a reliable account of the condition of the glass industry in 1833 and for a list of the factories and their proprietors of that date.

District	Name of Proprietors	Where Situate
Bristol	Henry Ricketts and Co.	Bristol
	John Nicholas and Co.	,,
	Thomas Powell and Co.	,,
	Coathupe and Co.	Nailsea-Heath
Durham	Isaac Cookson	South Shields
	Richard Shortridge	,,
	Charles Atwood	Southwick
	Addison, Fenwick and Co.	Sunderland
	Walker Featherstonhaugh	Ayres Quay
	Walker Featherstonhaugh	Deptford
	William Booth and Co.	,,
	John Hubbard	,,
Leeds	William Usherwood	Worsboro' Dale
	John Bower	Hunslet
	Noah Turner	Thornhill Lees
Birmingham	Hannah Shakespear and Co.	Birmingham
	John Biddle	,,
	Rice Harris and Co.	,,
	George Bacchus and Co.	,,
	William Gammon and Co.	,,
Liverpool	Abraham Akers and Co.	Newton
	Thomas Cockburn and Co.	Thattoheath
	W. A. A. West and Co.	,,
	John William Bell	Ravenhead
	Peter Greenall and Co.	St Helens
	Thomas Moore and Co	Kendrick's Cross
	James Holt and Co.	Liverpool
	Thomas Choll and Co.	Old Swan
	William Foster and Co.	Vauxhall Road
Manchester	Thomas Molineux	Manchester
	Daniel Watson and Co.	,,
	William Robinson	,,
	William Maginnes and Co.	,,
	Frederick Fareham	,,
Newcastle	Charles Atwood	Gateshead
	Joseph Price	,,
	George Sowerby	,,
	George Stevenson	Carr Hill
	Joseph Price	Newcastle
	Isaac Cookson and Co.	,,
	Joseph Lamb and Co.	,,
	Joseph Lamb and Co.	Lemington
	John Carr and Co.	Hartley Pans
	John Cookson and Co.	Bell Quay
	Thomas Ridley and Co.	St Peter's
	William Richardson and Co.	,,
	Sir M. W. Ridley and Co.	Newcastle
	Robert Todd and Co.	,,

District	Name of Proprietors	Where Situate
Warrington	John Clare	Warrington
	John B. Falkner and Co.	,,
	John Alderson and Co.	,,
	Thomas Robinson and Co.	,,
Salop	John Biddle and Co.	Moss
	John Biddle and Co.	,,
Sheffield	Close and Clark	Rotherham
	Thomas May	Catcliffe
Stafford	John Davenport	Longport
Stourbridge	William Chance	Spon Lane
	Joseph Guest and Co.	Dudley
	Thomas Hawkes	,,
	Joseph Stevens and Co.	Hollyhall
	Thomas Badger and Co.	Dudley
	Thomas Davis and Co.	Dickson's Green
	Joseph Silvers and Co.	Moore Lane
	Edward Westwood and Co.	,,
	William S. Wheely	Brettle Lane
	Michael Grazebrook	Audnam
	Thomas Littlewood	Holton End
	Richard B. Usell	Wordsley
	Thomas Hill	Coalburn Brook
	Thomas Webb and Co.	Wordsley
	John H. Pidcock and Co.	Platts
	Philip Rufford	Stourbridge Heath
	Sarah Ensell	Wordsley
York	Jepson and Co.	Mear
	Charles Priestly	York
London	Apsley Pellatt	Holland Street, Blackfriars
	William Christie	Stangate
	William Holmes	Whitefriars

CHAPTER XIII

THE INTERNATIONAL EXHIBITIONS OF 1851 AND 1862

THE belief that International Exhibitions would promote educatio art, science and manufactures has proved to be almost as fallacio as the hope that they would create lasting peace. The Great Exhibition of 1851 was educational because it genuinely represented the contemporary condition of art, science, and manufactures, but its successors have not been equally successful. The promoters, going the way of least resistance and most profit, have catered more and more for the amusement of the masses, and consequently the educational side has degenerated into an unappreciated background for switchbacks and water-shoots. The promoters; it is true, have some cause to complain of the default of manufacturers, especially those connected with applied art, many having yielded to the deterrent pressure of retail dealers, who feared the effect on their own businesses of direct contact between producers and users.

The effect of this pressure became apparent in the 1862 Exhibition, in which retail shops were more in evidence than manufactories. Although the number of exhibits of glass had considerably increased, only ten manufacturers exhibited in 1862 against seventeen in 1851.

The official catalogues are a useful basis for the contemporary history of glass-making. They record the districts in which glass was being made, the names of manufacturers and the character of the goods produced. The illustrations give some idea of the artistic condition of applied art and suggest that the standard was not very high and that, even as late as 1862, refinement was in a great measure sacrificed to the advertising effect of excessive size or inappropriate and unnecessary decoration.

Considering the recent date of the removal of the crippling fetters of the excise regulations it is remarkable that the glass section in the 1851 Exhibition should have been so extensive and should have included so many new developments.

One specially noticeable fact is that all the buildings of the Exhibition were cased in *sheet* glass, although in the evidence produced before the Excise Commissioners in 1833 it was stated that in England crown-glass was almost universally used for glazing.

A list of representative exhibits in the two exhibitions is arranged in the alphabetical order of the glass-making districts from which they came:

BIRMINGHAM:

George Bacchus and Sons.

1851. Cut, engraved and coloured table glass; table glass cased with colour; table glass decorated with enamel painting and gilding.

Harris Rice and Co., Islington Glass Works.

1851. Pressed table glass.

Lloyd and Summerfield, Birmingham Heath.

1851. Cut and engraved table glass; glass medallion busts; coloured sheet-glass for church windows.

1862. Table glass; glass window-bars; coloured sheet-glass.

Osler, F. and C., Broad Street.

1851. Cut-glass fountain, 25 feet high; candelabra; frosted glass busts.

1862. Cut-glass candelabrum, 20 feet high.

BRISTOL:

Coathupe and Co., Nicholas Street.

1851. Glass water-pipes, plain, jointed and angular; glass curtain-poles.

DURHAM:

Hartley and Co., of Sunderland.

1851. Patent rough plate-glass, of improved surface, one-eighth inch thick, 30 ounces weight to one square foot. Hartley and Co. tendered to supply this glass for glazing the Exhibition buildings, but their tender was not accepted because it was estimated that the weight of the glass would create excessive strain on the structure.

Moore, Edward and Co., South Shields.

1862. Flint table glass, pressed.

IRELAND:

Gatchell, George, Anne Street, Waterford.

1851. Etagère, consisting of forty pieces of cut-glass, fitted together for a banqueting table; vases with covers; cut table glass.

LONDON:

Pellatt, Apsley and Co., Falcon Glass Works, Holland Street, Blackfriars.

1851. Highly refractive cut-glass chandelier, 24 feet in length; chandelier, "Alhambra style," in white, ruby and blue glass; cut table glass; frosted table glass; cameo incrustations.

1862. Cut and engraved table glass; chandeliers.

Powell, James and Sons, Whitefriars Glass Works.

1851. Cut and engraved table glass; glass dessert service; epergne; cut-glass chandelier; glass pipes, fitted with patent joints for water or gas; "precipitation" and other glasses for scientific purposes.

1862. Table-glass; chandeliers; wall lights; vases with inlaid photographic decoration; "Venetian" opal glass; optic plate; coloured sheet-glass, resembling that of thirteenth and fourteenth centuries; glass jars for museums; glass tube; glass water-pipes.

Thames Plate Glass Company, Bow Creek, Blackwall.

1851. Plate-glass, plain and silvered; the largest plates hitherto produced.

MANCHESTER:

Molineaux Webb and Co., Ancoats.

1851. Cut, engraved and coloured table glass.

NEWCASTLE-ON-TYNE:

Swinburne, Robert Walter.

1851. Silvered, naked, rough and Venetian plates of glass.

Northumberland Glass Company.

1862. Flint table glass.

STOURBRIDGE:

Chance Bros. and Co., Spon Lane.

1851. Sheet-glass used for Exhibition buildings, sheets measuring 49 inches by 10 inches, weight 16 ounces per 1 square foot; complete lighthouse, with dioptric lenses; great refracting telescope with achromatic lenses; tables of crown-glass up to 66 inches in diameter; patent plate-glass; coloured window-glass; glass shades up to 83 inches in height; discs of flint-glass and crown-glass for telescopes; extremely thin glass for the polarisation of light.

1862. Crystal sheet-glass, made with sulphate of soda, warranted not to sweat; glass tiles; glass gauge tube; microscopic glass; optical glass for telescopes, microscopes and cameras; photographic glass; lenticular lighthouse glass; a first order revolving light.

Davis, Greathed and Green, Stourbridge.

1851. Table glass, cut and coloured.

Hodgetts, W. J., Wordsley.

1862. Table and toilet glass, cut and engraved.

Richardson, H. B. and J., Wordsley.

1851. Cut and engraved table glass; opal vases painted with enamel colour.

Webb, Thomas, Platts Glass Works.

1851. Table glass.

YORK:

Aire and Calder Glass Bottle Company.

1851. Bottles for dispensing, confectionery and soda-water; pressed glass stoppers; insulators for electric wires.

1862. Bottles.

Kilner Brothers, Dewsbury.

1862. Bottles.

The number of exhibitors recorded in the official catalogue of the 1851 Exhibition seems extremely small when compared with the long list of glass-manufacturers in the *Report* of the Excise Inquiry of 1833. Very many, however, of these manufacturers produced only crown-glass

or common bottles and could derive no advantage from exhibiting. It will also be noticed that most of their works were small and contributed insignificant amounts to the excise revenue. It may be assumed that in the 1851 Exhibition all, or nearly all, the enterprising and up-to-date manufacturers were represented.

Exhibitors of Stained or Painted Glass in the Exhibitions of 1851 and 1862

1851. Ballantine and Allan, George Street, Edinburgh.
Chance Bros. and Co., Birmingham.
George Hedgeland, Lisson Grove, London.
Michael and Arthur O'Connor, Berners Street, London.
James Powell and Sons, Temple Street, London.
St Helens Crown Glass Company, St Helens.
William Wailes, Newcastle-upon-Tyne.

1862. Ballantine, James and Son, George Street, Edinburgh.
Chance Bros. and Co., Birmingham.
Hardman, John and Co., Great Charles Street, Birmingham.
John Clayton and Alfred Bell, 311, Regent Street, London.
Cox and Son, Southampton Street, London.
Alexander Gibbs, 38, Bedford Street, London.
Heaton, Butler and Bayne, Cardington Street, London.
Lavers and Barraud[1], Endell Street, London.
Morris, Marshall, Faulkner and Co., 8, Red Lion Square, London.
O'Connor, M. and A. and W. H., 4, Berners Street, London.
Powell and Sons[2], Whitefriars Glass Works, London.
Ward and Hughes, 67, Frith Street, London.
Warrington, J. P., Hart Street, London.

[1] Cartoons by F. B. Barraud, N. H. J. Westlake, J. Bentley and E. Burne-Jones.

[2] Specimens of painted glass from drawings by W. Pollen, G. F. Street and E. Burne-Jones.

CHAPTER XIV

EXTRACTS FROM THE NOTES OF A FLINT-GLASS WORKS MANAGER FROM 1875–1915

THE normal output of the works in 1875 was table glass, tube, and coloured glasses for church windows.

The works manager's training consisted in courses of chemistry, glass analysis, and visits to glass-works, potteries, and clay-works.

The books available, which proved to be helpful, were Professor F. S. Barff's *Cantor Lectures* on silicates and glass (1872) and G. Bontemps's *Guide du Verrier*, 1868. Articles on glass in manuals and dictionaries of chemistry were generally found to be misleading.

In July 1875, M. de la Bastie came to the works and superintended experiments in his process of "glass toughening"; various mixtures of oil and tallow were used at various temperatures.

In August 1875, M. de la Bastie's paper on "toughened glass" was read at the Society of Arts. Tumblers treated at the works were tested at the meeting. Experiments were carried on at the works for some time, one of which resulted in a rather serious fire. Some miners' lamp-glasses were made for the late Mr Plimsoll. A paper was contributed to the *Journal of the Society of Arts* describing a modified process of "toughening" adopted at the works, explaining the physical condition of *hardened* glass and its limitations, and referring to microscopic examinations of fragments of the glass. This forecast of "toughened" glass, of which so much was expected, has proved fairly accurate. It was reproduced in the ninth edition of the *Encyclopaedia Britannica*.

In 1875 crude ashes were still very ineffectually refined at the works. The sand (Fontainebleau) was washed as well as burnt. Experiments having proved that little advantage was gained by washing the sand, the process was abandoned. The crushed natural oxide of manganese was used in the flint-glass batch to neutralise the iron. As the natural oxide was rarely free from iron, the precipitated oxide of manganese was substituted.

Experimental batches were melted containing salts of didymium and of erbium, supplied by the late Dr W. G. Lettsom. Professor Clifton, of the Clarendon Laboratory, Oxford, acknowledging specimens of these glasses, said, "They show the absorption spectra magnificently and will be very useful to me."

1876. White specks or "stones" in the glass were commonly attributed to defects in the glass mixture. Professor Barff, writing on April 28th, 1876, said, "On microscopic examination I found that the white substance is a glass and crystalline, and by analysis that it contains alumina. I have no doubt but that the pots are in fault."

The steps taken to prevent specks in glass were: (1) The weekly examination of the pots, (2) the removal of pots directly specks appeared, (3) the filling in of a layer of cullet before the batch-mixture, (4) slow filling, to prevent chilling the pots, (5) the home manufacture of pots under careful supervision. Experiments were also made to test the corrosive effect of various materials by fusing them in small clay crucibles.

In 1876 a pyrometer was unsuccessfully tried to test the heat of the furnaces.

In 1877–9 many experiments were made for decorating the surface of table glass and vases, (1) by iridising the surface by acid, (2) by "marvering" on leaves of gold or platinum, (3) by "marvering" on flakes of mica.

Coloured opal glasses, "blue" and "straw," were introduced, and duplex shades, made in these coloured opals, were sent to the United States in considerable quantities.

Mosaics. Many coloured opaque glasses were made for the mosaics of the morning chapel of St Paul's Cathedral.

In 1878 the table glass for the Prince of Wales's Pavilion in the Paris Exhibition was designed and made.

1880. Article on Glass for Spon's *Encyclopaedia*.

Experiments for colours with antimony, cadmium, iridium, and thallium.

1881. "Chameleon" glass (dichroic ruby glass, red and blue) used for vases.

1882. *Principles of Glass Making*, written for Messrs Bell and Co., Messrs Henry Chance and H. G. Harris co-operating.

1884. Coloured glasses made to serve as tests of urine.

1885. Bulbs for incandescent electric light made by hand in considerable quantities.

1886. Experiments to test the effect of wood charcoal as a source of colour. The colour ranged from pale lemon to opaque blackness, according to the amount added to the glass.

1889. Juror for glass at the Paris Exhibition.

"Alsatian" glass, a soda-lime glass, coloured blue with iron, used for vases; mixture based on analysis of ancient Roman glass.

"Venetian" glass, a soda-lime glass, based on analysis, used for vases and table glass.

A black glass made for reflectors for Messrs Casella.

1890. Eye tube and colours for artificial eyes (lead-potash base).

Experimental coloured enamels made for dental plates.

1891. Experiments for colour with nickel.

1892. In order to hasten the "plaining" of glass, Professor Vivian Lewes injected oxygen into a pot of semi-fused flint-glass. The effect was inappreciable.

1893–1904. Many coloured enamels were made for the mosaics of the choir of St Paul's Cathedral.

1893. Six experimental glasses made, specific gravity ranging from 3·2–4·6.

1895. Letter from Professor Dewar, of the Royal Institution, August 13th: "I am in extremity because of the want of larger vacuum vessels for liquid air." October 16th: "I have this day tested thoroughly the 'Powell vacuum vessels,' and I am delighted to tell you that they have stood every test."

1896. X-ray tubes. Mr L. P. Casella writes in September: "Having made a number of experiments with the last batch of soda glass, I have pleasure in saying that you have certainly succeeded, the tubes yielding a good supply of X-rays."

1897. Coloured glasses of thirteenth and fourteenth centuries compared by spectroscope with modern glasses.

Seven special glasses made for Lord Berkeley's experiments in electrolysis.

Five special glasses made for Professors Gray and Dobbie for experiments to illustrate the connection between electrical properties and the chemical composition of different kinds of glass.

Experiments commenced for a glass suitable for making accurate thermometers. It was ascertained that the result desired could not be obtained by thorough annealing, only. The first glass was based on an analysis of Jena glass 16, iii, alumina being introduced as felspar. Specimen thermometers were sent to the National Physical Laboratory and to J. J. Hicks, of Hatton Garden. Mr Hicks, writing in November, 1898, says: "I have been carefully trying the glass for the last eight or nine months in comparison with Jena glass, and I am pleased to find that there is no difference."

Thermometers made of new glasses were sent to the National Physical Laboratory in 1900, 1901, 1902, 1905, and November 12th, 1915. The Report of the National Physical Laboratory on the "1915" thermometers (marked *A* and *B*) is dated February 25th, 1916. "In the zero tests they were compared with a thermometer made of Jena combustion tube, the most successful we have come across for highest temperature ranges. Glass *B* is quite good; the enamel showed no sign of deformation. The experiments already carried out indicate that up to 100° or more the *B* glass is unusually good."

Glass for accurate thermometers was exhibited at the Optical Convention, 1905.

1900. Experiments with glasses containing phosphoric anhydride.

Experiments for colour with vanadium (repeated 1908).

Article on glass for tenth edition of the *Encyclopaedia Britannica*.

1902. Sand from Muckish Mountain, Ireland, used for flint-glass.

1903. Experiments for colour with tellurium and selenium; a glass coloured with selenium was exhibited at the Arts and Crafts Exhibition, 1906.

1904–5. A ten-pot furnace was adapted for heating with oil-gas tar and steam jets. System abandoned on account of cost of the oil-gas tar.

1906. Borax glass, to act as conductor of electricity, melted for Mr C. E. S. Phillips.

Inquiry by Sir W. Ramsay about change of colour in gold ruby glass.

1907. "Salts" on flint-glass traced to sulphate in the red-lead. The red-lead contained 2 per cent. of sulphate of lead.

A pyrometer tested, but proved useless.

Articles on glass for the eleventh edition of the *Encyclopaedia Britannica*, Dr Rosenhain contributing sections on optical glass and sheet-glass.

1910. The Féry optical pyrometer tried and found to be successful.

1911. Commenced melting glasses for Sir William Crookes's researches to find an anti-cataract spectacle glass, cutting out heat rays and ultra-violet rays.

Experiments for windows for X-ray bulbs; the most successful glass contained lithium borate.

Rhodius Bros. (German) red-lead was found to contain 0·135 per cent. of oxide of iron. The flint-glass was seriously discoloured.

Glass for X-ray bulbs containing carbonate of lithium.

Experiments with thorium.

1913. Special coloured glasses made for the east window of Liverpool Cathedral, and the apsidal windows of St John's Cathedral, New York.

Experiments with glasses containing fluorides.

September, 1914. Glass for chemical apparatus tested for resistance to alkali, resistance to acid, and resistance to changes of temperature.

1915. Glass for X-ray shields; specific gravity, 3·37.

July, 1915. Inquiry by Professor R. T. Glazebrook as to possibility of obtaining quick supply of optical glasses from ordinary flint-glass works. Manager stated that flint-glass works, as at present constituted, could not be adapted to produce an appreciable quantity of good optical glass unless almost completely re-organised and re-equipped.

CHAPTER XV

GLASS-MAKING DURING THE WAR, 1914–18

THE word parlous aptly describes the condition of the English glass trade before the war. Chance Bros. kept alive with difficulty the manufacture of optical glass. A few automatic bottle-making machines had been introduced in some of the Yorkshire bottle-works, and there were slight signs of vitality in the manufacture of hand-made and artistic table ware.

The unfortunate condition of the glass trade was attributed by men of science to ignorance and want of initiative on the part of the manufacturers; but by the manufacturers it was attributed to free trade, unfair trading conditions, and to the gulf dividing industrial from academic chemistry.

The effect of free trade on the glass industry had been disastrous. Glass of all kinds, produced under conditions widely different from those existing here, came from abroad, and could be sold at prices actually below or very slightly in advance of the cost of production in England. Succeeding Governments were apathetic as to the fate of the industry. All was satisfactory, provided glass could be cheaply bought. Furnaces were damped down, works dropped out, and recruits for the trade were difficult to obtain. Manufacturers were gradually driven to relinquish one staple product after another. The following examples will illustrate the prices at which foreign table glass was imported. Tumblers came into the country at 7*s.* 9*d.* per gross, wine glasses at from 1*s.* 3*d.* to 3*s.* 6*d.* per dozen, pint water bottles (including water tumblers) at 2*s.* 8*d.* per dozen. The price of laboratory glass ware was on a similar scale: foreign test-tubes could be sold retail in London at from 1*s.* 6*d.* to 6*s.* per gross; hard-glass Jena beakers, 50 c.c., at 3*s.* 9*d.* per dozen; 100 c.c., at 4*s.* 6*d.*; 500 c.c., at 9*s.*; and 1000 c.c., at 12*s.* 6*d.* per dozen. Jena flasks 50 c.c., at 3*s.* 6*d.* per dozen; 100 c.c., at 3*s.* 9*d.* per dozen; 500 c.c., at 8*s.* 6*d.* per dozen; and 1000 c.c., at 12*s.* 6*d.* per dozen. French and German soda-glass tube could be purchased at $3\frac{3}{4}$*d.* per lb.

English flint-glass manufacturers were, before the war, accused of short-sightedness and want of initiative because they hesitated to adapt their works for the production of laboratory ware. Their prospect of financial success was microscopic. In justice to the English manufacturers it must be remembered that the German and Austrian furnaces and pots were and are adapted for melting a leadless glass, whereas the English furnaces and pots were adapted for melting a glass containing lead. Although the leadless (lime-soda-alumina glass) is better suited for making laboratory ware than a glass containing lead, it does not follow that it is for all purposes a better glass. Of the many hundreds of different glasses which are now made, the lead-potash glass, as a glass, is probably the most scientifically perfect. At the commencement of the war, in order to meet war requirements manufacturers to a large extent gave up making lead-glass, and made lime-soda-alumina glasses in its place. There was naturally immense difficulty in building new works and in adapting old ones. The best was made of all sorts of makeshifts, and the work was done. The difficulty of obtaining materials was also very great.

Carbonate of potash disappeared, the price having risen from £21 to £48 per ton, and was replaced by saltpetre. The price of other materials rose as follows: saltpetre, £26 to £64 per ton; red-lead, £23. 10*s*. to £56 per ton; Fontainebleau sand (delivered in London), 21*s*. to 44*s*. per ton; white trioxide of arsenic, 32*s*. to 175*s*. per cwt.; precipitated oxide of manganese, 3*s*. 6*d*. to 12*s*. 6*d*. per lb.

The declaration of war brought about many changes in the works with which the author was connected, and which in pre-war times produced painted-glass windows and mosaics, table ware of all kinds, enamels, coloured glasses and tube. The manufacture of vases and of fancy table ware was abandoned, and the cutting-shops were denuded of men. A wine glass chair drew tube for mine-horns; a decanter shop blew X-ray bulbs; a fancy chair made medical glass, and the output of clinical thermometer glass was doubled.

A number of soda-lime-alumina glasses were introduced for mine-horns, for X-ray bulbs, and for ordinary temperature and high-temperature thermometers. Resistance glass in four colours was made for ampoules. In smaller quantities, enamels were made for thermometers, sealing-flux for X-ray bulbs, blue enamel for cat's-eye levels, and white opal for arc-lamp shades.

Sheet-glass containing oxide of didymium was blown for Sir W. Crookes, and sheet-glass containing oxide of uranium for the Admiralty. A neutral glass was made for goggles for acetylene welders, and a dense black glass for goggles for airmen. Glasses for anti-heat and anti-glare spectacles (the latter containing oxide of cerium) were also made. Glasses and enamels were melted for artificial eyes, and dense lead-glass for X-ray shields. From the special mine-horn glass six hundred thousand horns were made for sea mines by the Hyposol Company, each mine-horn having first been tested by being taken from boiling water and plunged into ice-water, and then by being twice dropped upon a sheet of lead from a height of 10 feet.

The following are summaries kindly sent to the author in 1919 by other glass-makers of their special war developments. The developments took the following forms: (1) new buildings; (2) new furnaces and equipment; (3) new departures in glass-making; and (4) increased output of staple productions. These developments were effected under great difficulties owing to shortage of men, and of materials. There was also a great shortage of seasoned glass-pots (crucibles), and rapid (sometimes unfortunate) decisions had to be made on the merits of competing types of recuperative and regenerative furnaces.

Bagley and Co., Limited, Glass Bottle Manufacturers, Knottingley, Yorkshire: "We have concentrated our efforts in installing Owen's automatic bottle-making machines."

Breffit and Co., Aire and Calder Glass Bottle Works, Castleford: "We have devoted ourselves almost entirely to making jam and fruit bottles and food containers."

Burtles, Tate and Co., Limited, Flint Glass Works, Manchester: "We have made new classes of goods, previously made abroad, viz.: chemical and lighting glass. We have increased our output by working eight-hour shifts."

Chance Brothers and Co., Glass Works, Smethwick, Birmingham: "Before the war, in spite of the competition of the Jena firm which received substantial support from the German Government, we continued to manufacture optical glass at a pecuniary loss. When war was declared, and the supply of German glass was cut off, our experience as makers of optical glasses proved of inestimable value and our output of optical glass has been increased twenty-fold. In addition to supplying home requirements we have to a considerable extent met the demands of the Allies. Our pre-war varieties of optical glass sufficed for the large majority of war requirements.

"Since the commencement of the war, the number of varieties has been greatly

increased, and now covers practically the whole range of those made, previous to the war, by German and French manufacturers; and in some cases we are now in a position to offer varieties which have not hitherto been listed. As an instance of this, we may mention fluor crown and dense barium crown of exceptionally low dispersion.

"An exacting programme of work was undertaken in connection with the demands of the Air Board for special types of glasses required for the manufacture of the finest anastigmatic objectives for aerial photography. This was successfully carried out, and the photographic lenses made with the glass produced by the firm have been acknowledged to be far superior to those used by the Germans for similar work.

"Special coloured glasses required for sextants and other optical instruments have also been investigated, and several types manufactured on a large scale, enabling us to offer four types of neutral tinted glass, besides plate glass for transmitting ultra-violet, a special transparent blue filter and a uranium glass of great intensity of fluorescence.

"The special new glasses which we were called upon to make were investigated in our research laboratory, and the formulae were worked out without any outside assistance. The statement in the press that the formulae and methods we had used for the manufacture of glasses required for gun-sighting telescopes, field-glasses and range-finders, had been supplied by outside sources, was entirely without foundation, and arose from confusion, on the part of the press between the Jena laboratory ware glass and Jena optical glass.

"In another department of our works we took up the manufacture of high-pressure lamp globes and heat-resisting glass, and have now captured the trade which, before the war, was entirely in the hands of enemy countries. We also produced in some quantity two types of Sir William Crookes' spectacle glasses. We made more than one and a half million goggles for the armies in Mesopotamia and in North Russia, and we cut ten million circles of sheet glass for gas-masks."

Duroglass Works, Walthamstow. Dr Morris W. Travers, F.R.S., till lately scientific director to Duroglass Ltd. (established by Messrs Baird and Tatlock in conjunction with himself in 1915), writes as follows: "After preliminary investigations of foreign glasses (used in the manufacture of scientific glassware) which were carried out in the chemical department of the Imperial College at South Kensington, a small experimental oil-fired furnace, capable of melting glass in quantities of about one hundredweight at a time, was erected at Walthamstow in March, 1915, and experiments were carried out on the basis of the information which had been collected.

"Tube and beakers were made from these glasses, and as the result of these experiments it was decided to proceed with the manufacture of:

(1) A soda-potash-lime-alumina-glass for lamp-working and

(2) A zinc boro-silicate resistance glass for beakers, etc., somewhat similar to Jena glass, but free from the defect of yielding zinc to acid solutions.

"By June, 1915, the manufacture of tube and hollow ware was being carried out

on a commercial scale, and during the following years the works were greatly extended, additional furnaces being built, with the necessary finishing shops for scientific hollow ware.

"The manufacture of graduated and lamp-blown apparatus was developed on a considerable scale. Special attention has been paid to the development of mechanical methods in all departments.

"The annealing of glass ware was very carefully studied, and the special gas-fired leers which have been installed, and which can be regulated with great exactitude, have proved a great success. Glass ware is tested by means of a 'Hilger' strain viewer before being sent out."

The Edinburgh and Leith Flint Glass Company: "We formerly made table-ware, but during the war changed over to electric-lighting bulbs of various types. We specialised in miniature lamps for miners' lamps; and lamps for trench and naval signalling. We have also specialised in wireless telegraph valve glass. We have made glass tube and rod and soft soda tubing for lamp work. We made a large number of experimental coloured glasses for various purposes. New furnaces, economical in fuel consumption, were installed."

The Edison and Swan Glass Works, Ponder's End, Middlesex: "By erecting new furnaces we have doubled our production of bulbs and tubing for incandescent electric lamps. Special glasses have been developed: (1) for bulbs for half-watt lamps; (2) for wireless telegraph valves; (3) special coloured glasses red, green and blue—for the Admiralty for signalling. These glasses had to be tested for the transmission of light of certain wave lengths; (4) a dark blue glass for ship lighting in cabins and holds, when the vessels were running with 'all lights out.' The light must be invisible at a distance of 100 yards on a clear night, and all red rays must be absorbed; and (5) opal tubing dense and transparent."

Greener and Co., Wear Flint Glass Works, Sunderland: "In order to meet the shortage of labour, due to the large number of men called up, labour-saving machines were obtained from America for making tumblers and other drinking vessels for the Army and Navy and for hospitals. These machines fully justified their heavy cost. Additional furnaces were installed. A large recuperative gas furnace was built by one man, with a lad to assist him, in eighteen months."

Molineaux, Webb and Co., Ancoats, Manchester: "We concentrated on lighting, chemical and medical goods, and gave up ordinary table glass."

Moncrieff, of the North British Glass Works, Perth, whose staple pre-war product was glass tube for gauge glasses, received an urgent wire on the morning following the declaration of war for glass parts for aeroplanes. These had to be made in the laboratory, but arrangements for lamp work on a larger scale were immediately set on foot.

The installation of new acid plants throughout the country necessitated the introduction of new methods of working up heavy tube at the lamp and at the furnace for the apparatus required. When the stocks of foreign combustion tube in this country were nearly exhausted, Messrs Moncrieff produced a combustion

glass, based on a formula supplied by the Institute of Chemistry, which is probably superior to the Jena combustion glass. By the end of 1914, at works taken for the purpose in Edinburgh, they were producing small quantities of laboratory ware, made of resistance glass. The majority of their glass-blowers having joined the Army, they were unable, owing to shortage of labour, to produce laboratory ware in any quantity until the spring of 1915. Early in 1916 the laboratory ware department was transferred to Perth, where a new twelve-pot furnace had been installed; since 1916 two new furnaces have been added. A demand for very large quantities of miners' safety-lamp glasses of approved quality has also been met.

Pilkington Bros., Glass Works, St Helens: "There has been little opportunity during the war to increase our trade. Over four thousand of our men joined up, mostly as volunteers, and we were obliged to close a large part of our works. That part of the plant where we were able to keep going has been largely devoted to the supply of glass required by the War Office and Admiralty. For instance:

1. Many millions of glass circles for the eye-pieces of anti-gas masks.
2. Large quantities of special photographic sheet glass for dry plates for the Air Service.
3. Practically the whole of the glass for soldiers' hutments in all parts of the United Kingdom and abroad, and for aerodromes and factories.
4. Glass screens for Mechanical Transport Service.
5. Glass for searchlight projectors.
6. Glass tables used in production of picric acid.
7. Non-actinic glass, to cut out the ultra-violet rays, for the roofs of aerodromes.
8. Special blue glass for the stern lights of battle and merchant ships to render interior lights invisible."

Stevens and Williams, manufacturers of table and decorative art glass, of Brierley Hill, near Stourbridge: "While supplying very large quantities of table ware for the Army and Navy, we added the manufacture of chemical and medical glass ware in considerable variety, miners' lamp glasses, electric bulbs and lighting glass ware. These developments and the serious depletion of our staff necessitated the abandonment of the production of decorative glass. For producing the various kinds of chemical, laboratory and lighting glass ware, a glass was used of a special formula."

Stuart and Sons, manufacturers of glass table ware, of the Red House Glass Works, Stourbridge, erected a new furnace for making electric light bulbs, and are now turning out about 40,000 bulbs per week.

Thomas Webb and Sons, manufacturers of table ware and decorative glass, of the Dennis Glass Works, Stourbridge, specialised, at the request of the Ministry of Munitions, in making electric lamp bulbs, glass tubing and rod, and are now turning out 400,000 bulbs per month in addition to from six to eight tons of tubing and glass rod. They also manufacture certain lines of chemical ware, such as funnels, test glasses, gas bottles, etc. Their output of table glass has been maintained. They are convinced that with some reasonable measure of protection this country could produce the bulk of the table glass required.

Christopher Wilson, Director of the Osram-Robertson Lamp Works, of Hammersmith, and of the Lemington Glass Works, Lemington-on-Tyne, said that before the war the Lemington Glass Works only turned out about 80 per cent. of the electric-light bulbs and glass tubing used for Osram-Robertson lamps. After the outbreak of war two large regenerative gas-furnaces were erected, which melted and plained flint-glass within twelve hours. The output of glass was enormously increased, and the shortage of labour was met by taking on and training boys of fourteen. Before the Armistice nearly half a million bulbs were being produced each week in addition to tube. Mr Wilson informed the author that he is now installing two American "Westlake" automatic bulb-blowing machines, which will greatly add to the speed and economy of production.

Wood Bros. Glass Company, Borough Flint Glass Works, Barnsley: "Prior to the war we were engaged almost solely in making flint glass bottles for pharmacists.

"After the declaration of war, and before the end of 1914, we were turning out fair quantities of electric-light bulbs. In 1915, we built a large extension to our works, and, with the assistance of Sir Herbert Jackson, successfully tackled the manufacture of all kinds of laboratory and scientific glass-ware. We also made flash-lamp lenses and X-ray bulbs. We built an additional furnace at the Derby Crown Glass Works, which had been started in 1913, mainly for the production of glass jars for potted meats, toilet cream and for malt. Early in 1916 the Derby Crown Glass Company, at the request of the Government, decided to erect large new works with laboratories entirely for the manufacture of optical glass. The first melt on a commercial scale was made on June 3rd, 1916. In spite of the magnitude of the research work involved, many tons of optical glass of the highest quality were supplied during the war. The present list includes over forty distinct types, including reproductions of some of the most famous German glasses.

"The company is greatly indebted to the Optical and Glassware Department of the Ministry of Munitions for assistance and encouragement."

This collection of reports on war developments is far from complete, but sufficiently illustrates the effort made by manufacturers to help to meet the innumerable demands created by war. Amongst the requirements were many distinct glasses which had never been made in England, even on an experimental scale. The industry was in a condition singularly unfitted to meet the crisis. Very few managers of works had received scientific training, because no institution existed where such training could be obtained, and there was no central scientific authority competent to give the guidance and help which were so much needed. No co-operation between the different works existed, and each manager, with very inadequate equipment for research, had to solve for himself the problems which confronted him. The many defects which war made

apparent have already to a great extent been remedied. Thanks are due to the University of Sheffield, for having taken the first step, by the creation of a Department of Glass Technology, to bring glass-making into closer contact with science. This step led to the formation of the Society of Glass Technology, which has already helped to promote co-operation between manufacturers. A Glass Research Association, subsidised by Government, has also been founded.

On the commercial side of glass-making steps have been taken to increase production by the formation of a combine with a capital of £2,000,000 embracing all departments of glass manufacture. By the enlargement of old works, the erection of new ones, the improvement of plant and furnaces, and the installation of every kind of useful automatic machinery, a mass production is aimed at which will suffice to meet all home demands and to resist all competition from abroad. It remains to be seen whether combination and the prosperity due to it will encourage or discourage the maintenance of the high standard of artistic work which had been attained by certain individual factories in the trying times before the war. If mechanically-produced table ware is inartistic and ugly, the fault lies with the designer. The mechanically made vessel which pretends to be hand-made or hand-cut must always be a pretentious and unsatisfactory fraud. It is quite possible, however, to design table ware for mechanical production which shall be gracious in form and which shall possess sufficient decoration to accentuate the beauty of the material. Designs, whether for hand-made or mechanically produced table ware, must be evolved from intimate acquaintance with the nature of molten glass and the technique of manufacture, rather than from the superior inner consciousness of the Art School.

THE END

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